YALE URBAN ECOSYSTEM SERVICES SYMPOSIUM

NEW TOOLS TO GUIDE ECOSYSTEM MANAGEMENT IN AN URBANIZING WORLD

KROON HALL, THIRD FLOOR
195 PROSPECT STREET
NEW HAVEN

YALE SCHOOL OF FORESTRY
& ENVIRONMENTAL STUDIES

JANUARY 24, 2014

ACKNOWLEDGEMENTS

The symposium is presented by the Hixon Center for Urban Ecology, the NYC Urban Field Station, the New York City Department of Parks & Recreation, the USDA Forest Service, and the Yale Office of Sustainability.

The symposium marks the start of a new partnership among Yale University, the Hixon Center for Urban Ecology, the Urban Resources Initiative, the NYC Department of Parks & Recreation, the US Forest Service, and the NYC Urban Field Station at the nexus of research and practice to advance livability and resilience in cities. The partnership will expand our work examining the interactions, impacts, co-benefits, and constituencies of natural resources and social systems in urban areas. Objectives of this partnership are to research and monitor various dimensions of social-ecological systems; to contribute to growing bodies of knowledge about urban ecosystems and their benefits; to provide research and practical experience for graduate students; and to support novel and time-tested programs of community-based resource management.

The ultimate goal of this collaboration is to improve the quality of life of urban communities through participatory research and applications.

GREEN ROOF ON NANYANG TECHNOLOGICAL
UNIVERSITY, SINGAPORE

ABOUT THE SYMPOSIUM

The realities of our urbanizing world and changing climate demand a shift in ecosystem services research and implementation. As a new, mission-based framework for natural resources management, the ecosystem services approach has traditionally focused on rural landscapes. However, in the wake of Hurricanes Katrina and Sandy and with on-going issues like urban water quality and climate change, researchers and urban planners are increasingly turning to the ecosystem services approach to understand and manage the natural resources of urban landscapes. Nature provides urban dwellers with clean air, clean water, rainwater drainage, sewage treatment, recreation, and cultural values, to name only a few urban ecosystem services. Meanwhile, humans—the dominant species of the urban ecosystem—innovate and act on many scales to produce and shape the urban nature that offers such critical values and services. Of these services, some of the most significantly affected by the demographic shifts and landscape transformations of urbanization include storm water regulation, flood mitigation, socio-cultural quality of life, and microclimate regulation.

The Urban Ecosystem Services Symposium will explore the application and utility of urban ecosystem services scholarship by bringing together academics on the cutting edge of this science and city managers using the approach for urban planning. The event will assess the major questions and merits of the urban ecosystem services approach across global, regional, city, and community scales. The Symposium will engage around questions emerging from these studies and projects to catalyze a discussion and comparison of promising approaches and limitations. Three overarching themes will be addressed:

- **DEFINING**: How can ecosystem services frameworks inform and inspire more sustainable and resilient city designs? What can such social and physical sciences explain about the natural resources of urban landscapes and the ecological systems of cities?
- **REVIEWING METHODS**: What tools are being used/developed to quantify, monitor, and describe the urban ecosystem services of cities? How have these tools been applied and what do they do that other approaches cannot?
- **MOVING FORWARD**: Where are the most critical opportunities for and practical applications of research on urban ecosystem services? What values are embodied in ecosystem services frameworks and what values are left out? What are the limitations of existing models and ecosystem services strategies?

URBAN TREE CANOPY, NEW HAVEN

SCHEDULE OF EVENTS

Breakfast 8:00-9:00

Welcome, Dean Peter Crane 9:00-9:15

Keynote, NYC Deputy Mayor Caswell Holloway 9:15-9:45
"How can ecosystem services help build sustainable, resilient cities?"

Presentation of Models 9:45-12:00
Approaches to Understanding and Quantifying Urban Ecosystem Services

Lunch 12:00-12:45

Afternoon Panels on Selected Bundles of Ecosystem Services

Panel One 12:45-1:45
Urban Micro-Climate

Panel Two 1:45-2:45
Green Infrastructure and Stormwater

Panel Three 3:00-4:00
Coastal Protection, Sea Level Rise, & Hurricanes

Panel Four 4:00-5:00
The Use and Stewardship of Multifunctional Landscapes

Closing Remarks, Gaboury Benoit 5:00-5:15

CLEANING THE SEINE RIVER WITH REED BEDS, PARIS

PRESENTATION OF MODELS

APPROACHES TO UNDERSTANDING AND QUANTIFYING URBAN ECOSYSTEM SERVICES

Presenters will showcase diverse ecosystem services models sharing how they can quantify, monitor, and describe the urban ecosystem services in cities. Panelists will explore how these tools have been applied, current limitations and what they accomplish that other models cannot.

PRESENTERS

Edward Barbier, University of Wyoming
"Valuing ecosystem services in urban areas"

Erika Svendsen, USDA Forest Service
"Visualizing our social infrastructure: Understanding and mapping urban environmental stewardship"

David Nowak, USDA Forest Service
"i-Tree: Assessing ecosystem services and values from trees"

Leslie Shoemaker, Tetra Tech
"Optimizing urban green infrastructure in a changing world"

Rob McDonald, The Nature Conservancy
"Quantifying the value of natural habitats in minimizing flooding risk"

PANEL ONE

THE URBAN MICRO-CLIMATE

The panel includes a mix of researchers, urban planners and municipal policy-makers to connect science and research to on-the-ground projects. What urban microclimate management strategies are being practiced and what goals (comfort, health, energy reduction) do we hope to achieve with them? Is the effectiveness of these management strategies quantifiable? How do we combine positive and negative effects into a common set of matrices? How should we improve current ways of measuring urban heat island to better represent human exposure?

PANELISTS

Winston Chow, National University of Singapore

Aaron Durnbaugh, Loyola University

Stuart Gaffin, Columbia University

Tom Matte, NYC Department of Health and Human Hygiene

MODERATOR

Xuhui Lee, Yale University

PANEL TWO

GREEN INFRASTRUCTURE AND STORMWATER

The panel includes a mix of researchers, regulators, community-based program managers and municipal policy-makers. The goal is to encourage a conversation that connects the most recent green stormwater infrastructure research, development and regulation to on-the-ground projects. The discussion will focus on questions like: Within the world of sustainable stormwater management, what do we need to care about next? What questions for research are the most pressing? Where are the gaps in knowledge? What are the barriers to widespread implementation?

PANELISTS

Ellen Gilinsky, Environmental Protection Agency

Mike Houck, Urban Green Space Institute at Portland State University

Aaron Koch, City of Chicago Department of Water Management

Franco Montalto, Drexel University

MODERATOR

Jennifer Hoyle, Yale University

PANEL THREE

COASTAL PROTECTION, SEA LEVEL RISE, AND HURRICANES IN NEW YORK CITY AND NEW ORLEANS

How are coastal cities working with natural capital to attenuate sea level rise and coastal flooding in extreme events? This panel will build on experience and case studies to elaborate on ecosystem services related to coastal adaptation. Building on the discussions on models in the morning, we will explore the relevance and shortfalls of the models used to assess coastal risks. What are the roles of FEMA, the Federal Flood Insurance Program, community disaster recovery funds and block grants, and scientists analyzing trade-offs between gray (levees) and green (marshes)? What lessons does New Orleans have for New York? What lessons are valuable across urban to rural gradients?

PANELISTS

Roselle Henn, USACE North Atlantic Division

Denise Reed, Water Institute of the Gulf

Gavin Smith, U.S. Department of Homeland Security's Coastal Hazards Center of Excellence

Dan Zarrilli, City of New York

MODERATOR

Alexander Felson, Yale University

PANEL FOUR

THE USE AND STEWARDSHIP OF MULTIFUNCTIONAL LANDSCAPES

This panel advances the notion that social and cultural processes are critical to the health and resilience of urban ecosystems; that these processes are complex; and that they require inquiry. The questions remain: how do we understand the role of social and cultural processes and infrastructure in urban ecosystems; and how do we factor this understanding into ecological assessments that so often rely on quantitative data and biophysical indicators? The conversation will explore the dynamics of social and cultural values and their bearing on urban ecosystem services, natural resource management, and human well-being.

PANELISTS

Lindsay Campbell, USDA Forest Service

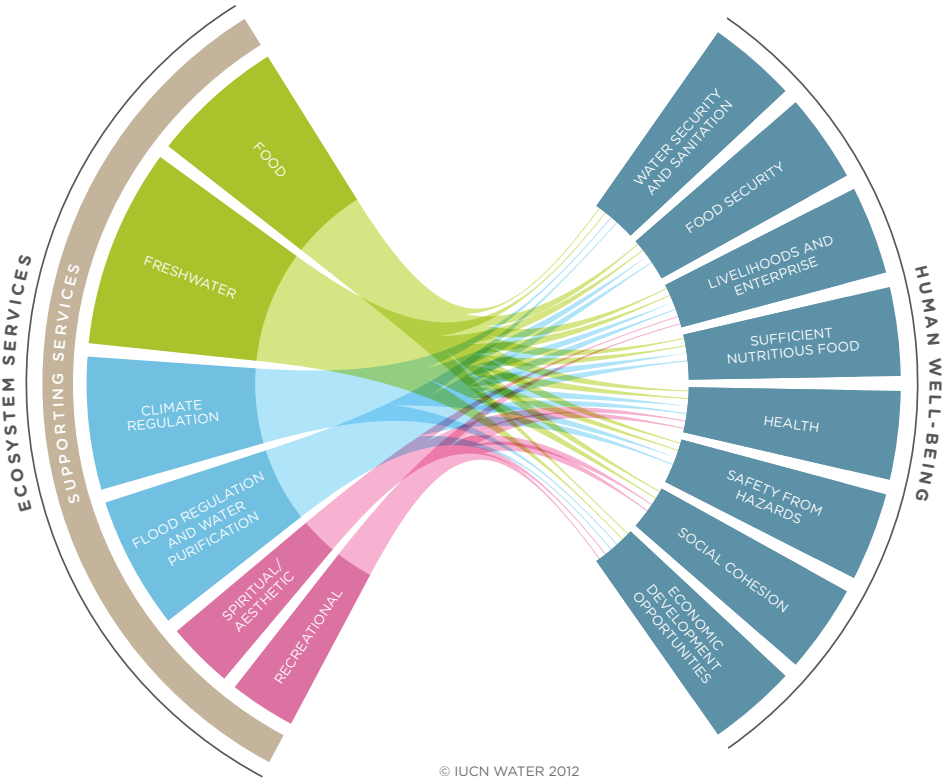
Morgan Grove, USDA Forest Service

Hans Hesselein, Gowanus Canal Conservancy

Keith Tidball, Cornell University

MODERATOR

Gillian Baine, USDA Forest Service



SPEAKER BIOGRAPHIES

DR. EDWARD BARBIER is the John S Bugas Professor of Economics, Department of Economics and Finance, University of Wyoming. His main expertise is natural resource and development economics as well as the interface between economics and ecology. He has served as a consultant and policy analyst for a variety of national, international and non-governmental agencies, including many UN organizations, the OECD and the World Bank. Professor Barbier is on the editorial boards of several leading economics and natural science journals, and he appears in the 4th edition of Who's Who in Economics. In 2008, he was named by Cambridge University as one of the 50 most influential thinkers on sustainability in the world, and among his honors and awards, he has received the 1991 Mazzotti Prize (Italy) for contributions to economics and ecology. Professor Barbier has authored over 200 peer-reviewed journal articles and book chapters, written or edited 21 books, and published in popular journals and media. His books include Blueprint for a Green Economy (with David Pearce and Anil Markandya, 1989), Natural Resources and Economic Development (2005), A Global Green New Deal (2010), Scarcity and Frontiers: How Economies Have Developed Through Natural Resource Exploitation (2011), Capitalizing on Nature: Ecosystems as Natural Assets (2011) and A New Blueprint for a Green Economy (with Anil Markandya, 2012).

DR. LINDSAY CAMPBELL is a research social scientist with the USDA Forest Service Northern Research Station. She is based at the New York City Urban Field Station, which is a partnership between the Forest Service and the NYC Department of Parks & Recreation. The NYC Urban Field Station is dedicated to improving the quality of life in urban areas by conducting and supporting research about social-ecological systems and natural resource management. Her current research explores the dynamics of urban politics, natural resource stewardship, and

sustainability policymaking. She is co-PI on several long term, interdisciplinary research projects. These include the Stewardship Mapping and Assessment Project (STEW-MAP), which maps the social networks and spatial turf of civic, government, and private actors working on environmental stewardship in New York City—and is now being replicated in Chicago, Baltimore, Seattle, Philadelphia, Los Angeles, and San Juan. As well, she helped lead the research of the Living Memorials Project, which examines the use and stewardship of open space post-September 11, and received the 2007 EDRA/Places Award for Research. She is a co-PI of the TKF-foundation funded "Landscapes of Resilience" team examining open spaces and sacred spaces in Joplin, MO and New York City. She is a member of the NSF-funded ULTRA-EX team examining changes in land cover, ecosystem services, and stewardship in New York City's urban forest. She is also a member of the MillionTreesNYC Advisory Committee and Research and Evaluation Subcommittees. Dr. Campbell holds a BA in Public Policy from Princeton University, a Masters in City Planning from MIT, and a PhD in Geography from Rutgers University.

DR. WINSTON CHOW is an urban climatologist who is currently an Assistant Professor at the Department of Geography, (NUS). Prior to this, he was a postdoctoral fellow affiliated with the College of Technology and Innovation at Arizona State University (ASU). A major component of his urban climate research examines the physical aspects and development of heat islands through both observational and modelling platforms, as well as in assessing their impacts and evaluating several geographic-specific means of its mitigation and adaption within the context of tropical and subtropical cities, where much future population growth will take place. Dr. Chow is also the present news editor of Urban Climate News, the quarterly newsletter of the International Association for Urban Climate. He holds Bachelors' and Masters' degrees in English and Geography from NUS, as well as a Ph.D in Geography from ASU's School of Geographical Sciences and Urban Planning.

AARON NOBLE DURNBAUGH is the Director of Sustainability for Loyola University Chicago. Working across the curriculum, culture and campuses of Loyola, Mr. Durnbaugh builds innovation and efficiency into the University's programs and student experience focusing on water protection, climate planning and social justice. Previously, he served as the Deputy Commissioner with Chicago Department of Environment's Natural Resources and Water Quality Division (NRWQ). Department of Environment was the lead agency developing and implementing the Chicago Climate Action Plan. NRWQ educated the public on climate change issues through the Chicago Center for Green Technology, Chicago Conservation Corps, and Greencorps Chicago. NRWQ created mitigation opportunities through wetland protection in the Calumet region, green infrastructure financing and various urban forestry projects. Most recently, Mr. Durnbaugh oversaw the City of Chicago's climate adaptation strategy engaging stakeholders in built environment, public health and the natural environment and co-authored the City's 2009 Urban Forest Agenda and 2011 update to the Nature and Wildlife Plan. He holds a Master's Degree in Geography and Environmental Studies, is a LEED™ accredited professional and serves on the Chicago Wilderness Executive Council.

DR. STUART GAFFIN is a Research Scientist at the Center for Climate Systems Research, Columbia University. Prior to joining Columbia in 2001, he was a senior scientist in the Atmosphere Program at the Environmental Defense Fund, NYC from 1989. His Ph.D. was in Atmospheric and Paleoclimate Studies from the former Earth Systems Group at New York University. Dr. Gaffin is a faculty member for the new undergraduate Sustainable Development Major first offered at Columbia University in 2011. He teaches the senior capstone workshop in sustainable development every Fall and Spring Semester. His current and recent areas of research include: (i) projections of New York City regional climate impacts including temperature, precipitation, extreme events and sea level rise; (ii) the urban heat island effect and the role of urban vegetation and high-albedo surfaces as mitigation strategies; (iii) greenhouse gas emissions scenarios and their

relation to regional population changes. Dr. Gaffin is also currently installing a new network of green and white rooftop monitoring and atmospheric research stations throughout the New York City area. Recent projects include sites in the Bronx, Morningside Heights, Queens and Brooklyn. This will provide a new network of observations for the city that will be useful for a number of issues including: distributed stormwater runoff control, atmospheric forecasts, modeling, energy demand and climate impacts. Dr. Gaffin taught the first courses offered by Columbia University on the New York City urban heat island in Spring 2005 and 2006. He was a lead author on the 2001 Intergovernmental Panel on Climate Change (IPCC) set of emissions scenarios, known as the "SRES" scenarios. He is the author of many peer reviewed journal articles, and has participated in numerous media and public forums on climate change science and policy.

DR. ELLEN GILINSKY serves as Senior Policy Advisor to the Acting Assistant Administrator for Water in the Office of Water at the Environmental Protection Agency. Prior to this appointment she spent seven years as the Director of the Water Division at the Virginia Department of Environmental Quality (DEQ), where she supervised a diverse array of water quality and quantity programs. She also served for five years at DEQ as Manager of the Office of Wetlands and Water Protection, helping to craft Virginia's non tidal wetlands program. Dr. Gilinsky has twelve years of experience as an environmental consultant at several regional and national environmental engineering firms, focusing on water issues. Dr. Gilinsky received her B.A. in Biology from the University of Pennsylvania and her Ph.D. in Zoology, with a concentration in Aquatic Ecology, from the University of North Carolina at Chapel Hill. Among her other professional accomplishments, she was a Past President of the Association of Clean Water Administrators, held a gubernatorial appointment to the State Advisory Board of the Virginia Water Resources Research Center and was an Adjunct Faculty member at Virginia Commonwealth University in the Departments of Biology and Environmental Studies.

DR. J. MORGAN GROVE is a Social Ecologist and Team Leader for the USDA Forest Service's Baltimore Field Station. He is a Co-Principal Investigator in the Baltimore Ecosystem Study (BES) LTER. Grove was a dual major in Architecture and Studies in the Environment from Yale College (B.A.), a M.F.S. in Community Forestry from the Yale School of Forestry & Environmental Studies, and a M. Phil. and Ph.D. in Social Ecology from Yale University. Grove has worked in Baltimore since 1989 and was a founding member of the BES LTER. Grove leads the social science team for BES, where his research focuses on long term dynamics of property regimes, land management, and watersheds. Grove is the science lead for the Urban Tree Canopy (UTC) software tools. In 2001, for his work in Baltimore, Grove was the first social scientist in the U.S. Forest Service to ever receive the President's award for early career scientists.

ROSELLE HENN is Deputy Director for the US Army Corps of Engineers (USACE), National Planning Center of Expertise for Coastal Storm Risk Management (PCX-CSRM), leading the Hurricane Sandy North Atlantic Coast Comprehensive Study (NACCS), from Jan 2013 to present. While compiling the study, scientists and engineers will consider future sea-level rise scenarios and integrate economic, climatological, engineering, environmental and societal data from Virginia to Maine to develop a comprehensive framework to reduce coastal flood risk and promote resiliency. Ms. Henn is the Environmental Team Leader for the USACE North Atlantic Division (NAD) with primary responsibility for ecosystem restoration throughout the region which extends from Maine to Virginia. In this capacity she is the Senior Subject Matter Expert on environmental policy and compliance, leading environmental teams located in NAD's five Districts (New England, New York, Philadelphia, Baltimore, and Norfolk) working on watershed planning and estuarine restoration. She is the regional environmental interface with other Federal Agencies including EPA, NOAA, and DOI, Regional Partners, and NGOs and represents NAD in collaborative efforts which transcend District/political boundaries, such as the restoration and protection of Chesapeake Bay, the Susquehanna and Delaware River Basin Commissions, and the Interstate

Commission for the Potomac River Basin and in Climate Change initiatives, Coastal America, the Mid-Atlantic Federal Partners on the Ocean, and the Corps Invasive Species Leaders Team.

HANS HESSELEIN, Executive Director of the Gowanus Canal Conservancy, grew up on a family-owned nursery in central New Jersey, cultivating a passion for plants at a young age. Hans graduated with a Bachelor's degree in Landscape Architecture from North Carolina State University in 2004. He has spent time working internationally in Germany as well as at several domestic landscape architecture firms, including a position as Associate at Dirtworks, PC in Manhattan. Hans joined the Gowanus Canal Conservancy as the Director of Special Projects in December, 2010 and was asked to serve as Executive Director in 2013. Throughout his time at the Conservancy, Hans has been responsible for developing and managing green infrastructure projects, watershed planning initiatives and volunteer stewardship programs. Hans comes to the Conservancy with a strong background in horticulture, construction technology, community engagement and landscape architecture.

CASWELL HOLLOWAY was appointed Deputy Mayor for Operations by Mayor Michael R. Bloomberg on August 4, 2011. As Deputy Mayor, Cas oversees 11 mayoral agencies and offices and assists the Mayor in overseeing the Police Department, Fire Department, Office of Emergency Management, Office of Management and Budget, and the Office of Labor Relations. After Hurricane Sandy Cas oversaw Rapid Repairs, the City's first-of-its-kind program to restore power, heat, and hot water to thousands of New Yorkers in their homes; and the creation of A Stronger, More Resilient New York, the City's plan for long-term resiliency. From January 1, 2010 until his appointment as Deputy Mayor, Cas served as the Commissioner of the New York City Department of Environmental Protection. Cas appointed DEP's first Deputy Commissioner for Sustainability; created an energy team to develop a new generation of natural gas and renewable energy investments; initiated Water for the Future, a $2 billion package of investments that will repair

leaks in the Delaware Aqueduct; and developed the NYC Green Infrastructure Plan to improve water quality in the City's waterways. From 2006 until his appointment at DEP, Cas served as Chief of Staff and Counsel to Deputy Mayor for Operations Edward Skyler and as Special Advisor to Mayor Bloomberg. He graduated cum laude from Harvard College and with honors from the University of Chicago Law School.

MIKE HOUCK, Executive Director of the Urban Greenspaces Institute, has worked on local, regional, and national urban park and greenspace issues since 1980 when he founded the Urban Naturalist Program at the Audubon Society of Portland. Houck's work over the past twenty years has focused on integration of the built and natural environments in the Portland-Vancouver region and incorporating green infrastructure for the city of Portland's watershed and stormwater planning efforts. He is co-founder of The Intertwine Alliance a new nonprofit dedicated to creating a world class park, trail, and natural area system for the Portland-Vancouver metropolitan region. The Alliance is also a member of the national Metropolitan Greenspaces Alliance whose members represent Chicago, Los Angeles, Houston, Cleveland, Milwaukee, San Francisco Bay Area, and Portland metropolitan greenspace initiatives.

AARON KOCH is the Deputy Commissioner for Sustainability in Chicago's Department of Water Management. He is responsible for implementing the water initiatives in Sustainable Chicago 2015, Mayor Rahm Emanuel's roadmap for environmental stewardship and economic development. Aaron previously served as a Senior Policy Advisor in the New York City Mayor's Office of Long-Term Planning and Sustainability. He was an author of the water chapters of PlaNYC, Mayor Michael Bloomberg's sustainability plan, as well as the New York City Wetlands Strategy and the Sustainable Stormwater Management Plan. As part of this work, he was a creator of New York City's strategy to improve stormwater management through a $1.5 billion public investment in green infrastructure. He holds a Bachelor of Science in Architecture from the University of Minnesota-Twin Cities, a Master of City Planning from the University

of Pennsylvania, and is a faculty member in Columbia University's Master of Sustainability Management program.

DR. THOMAS MATTE is Assistant Commissioner for Environmental Surveillance and Policy at New York City Department of Health and Mental Hygiene (NYCDOH) where he has directed studies to improve risk assessment, surveillance, and public health prevention efforts related to air pollution, summer heat waves and other extreme weather events in NYC and has served on the New York City's inter-agency Climate Change Adaptation Task Force. Tom also led the development of the New York City Community Air Survey, a landmark study of variation in street-level air pollution exposure across the city to inform local air quality improvement initiatives. Dr. Matte previously worked as a medical epidemiologist with the CDC and as Professor of Urban Public Health at Hunter College and the CUNY School of Public Health. His past work has spanned several environmental and chronic disease areas, including: lead exposure domestically and abroad, prenatal and early life exposures and their relationship to later health status, and evaluation of major NYC health initiatives including nicotine patch distribution, a trans-fat ban and calorie labeling initiatives.

DR. ROBERT MCDONALD is the Senior Scientist for Urban Sustainability at The Nature Conservancy. He researches the impact and dependences of cities on the natural world, and is the lead scientist for much of the Conservancy's urban conservation work. Currently Dr. McDonald is leading a global team of scientists mapping where the cities of the world get their water, and evaluating their dependence on ecosystem services and their vulnerability to climate change. He is also working on a book, entitled "Conservation for Cities", which documents the role green infrastructure can play to the well-being of urban residents. Another major research interest is the effect of U.S. energy policy on natural habitat and water use. Prior to joining the Conservancy, Dr. McDonald was a Smith Conservation Biology Fellow at Harvard University, studying the impact global urban growth will have on biodiversity and conservation. He also taught landscape ecology at Harvard's

Graduate School of Design, helping architects and planners incorporate ecological principles into their projects. He holds a B.S. degree in biology from The University of North Carolina at Chapel Hill and a Ph.D in ecology from Duke University.

DR. FRANCO MONTALTO, PE is a licensed civil/environmental engineer and hydrologist with 20 years of experience working in urban and urbanizing ecosystems as both a designer and researcher. His experience includes planning, design, implementation, and analysis of various natural area restoration and green infrastructure projects. As an Associate Professor in Drexel University's Department of Civil, Architectural, and Environmental Engineering, he currently directs the Sustainable Water Resource Engineering Laboratory. He also heads up the Green Infrastructure Sector of the NOAA-funded Consortium for Climate Risk in the Urban Northeast (CCRUN), a five-year research initiative. Dr. Montalto is also the founder of eDesign Dynamics LLC, a consulting firm based In New York City that specializes in green infrastructure and ecological restoration. Previously, Dr. Montalto served as the Wetlands Engineer at the New Jersey Meadowlands Commission, where he was responsible for the engineering design of the 139-acre Mill Creek Marsh in Secaucus, NJ among other large urban wetland restoration projects. He has worked overseas in various capacities in Europe, Africa, the Caribbean, and Latin America and is the author of numerous publications in the water resources and environmental fields. He was also formerly a Fellow at the Earth Institute at Columbia University, a Fulbright Scholar, and an Adjunct Professor at the Cooper Union for the Advancement of Science and Art, where he received his first degree. His graduate degrees are from Cornell University.

DR. DAVID J. NOWAK is a Project Leader with the USDA Forest Service, Northern Research Station in Syracuse, NY. He has authored over 225 publications and is a recipient of the: National Arbor Day Foundation's J. Sterling Morton Award; R.W. Harris Author's CitaDavid J. Nowak is a Project Leader with the USDA Forest Service, Northern Research Station in Syracuse, NY. He has authored over 225 publications and is a recipient of the: National Arbor Day Foundation's J.

Sterling Morton Award; R.W. Harris Author's Citation from the International Society of Arboriculture; American Forests' Urban Forest Medal; Distinguished Science Award of the Northeastern Research Station; Forest Service Chief's Honor Award for Engaging Urban America and the New York State Arborists-ISA Chapter Research Award. Dr. Nowak was also contributing member of the 2007 Nobel Peace Prize winning Intergovernmental Panel on Climate Change. His research investigates urban forest structure, health, and change, and its effect on air quality, water quality and greenhouse gases. He also leads teams developing software tools to quantify ecosystem services from urban vegetation (e.g., UFORE and i-Tree programs). Dr. Nowak received a B.S. and M.S. from SUNY College of Environmental Science and Forestry, and a Ph.D. from the University of California, Berkeley.

DR. DENISE REED is the Chief Scientist for the Water Institute of the Gulf. She is a nationally and internationally recognized expert in coastal marsh sustainability and the role of human activities in modifying coastal systems. She has worked on coastal issues in the US and in other parts of the world, for over 30 years. Dr. Reed has been extensively involved in restoration planning in coastal Louisiana since the early 1990's with a focus on bringing scientific knowledge to bear in developing sustainable solutions. Reed has also been engaged in ecosystem restoration research and planning both in the California Bay-Delta. She has served on numerous boards and panels concerning the effects of human alterations on coastal environments and the role of science in guiding ecosystem restoration, including a number of National Research Council Committees. She received her BA and PhD from the University of Cambridge in England.

DR. LESLIE SHOEMAKER joined TetraTech in 1991, and she is currently responsible for our strategic planning, business development, sustainability, and corporate communications functions. Dr. Shoemaker coordinates our Strategic Initiatives Program, which supports company-wide collaboration on key services in our major growth markets. Dr. Shoemaker is our Chief Sustainability Officer. She also leads the water resources modelling and systems development team and

consults on the development of policy and programs for watershed management and sustainable communities. Dr. Shoemaker has more than 25 years of industry experience and has previously served in various technical and management capacities including project engineer, project manager, vice president, and technical practice leader. Dr. Shoemaker holds a B.A. degree in Mathematics from Hamilton College, a Master of Engineering from Cornell University, and a Ph.D. in Agricultural Engineering from the University of Maryland.

DR. GAVIN SMITH is the Executive Director of the Department of Homeland Security's Coastal Hazards Center of Excellence. Dr. Smith is currently engaged in planning-related research within the center, focused on a national evaluation of local and state hazard mitigation plans, the study of state recovery plans, and the development of sea level rise adaptation strategies. Dr. Smith has published numerous book chapters, peer-reviewed journal articles, and technical reports addressing a range of topics including hazard mitigation, disaster recovery, and climate change adaptation. Dr. Smith is an Associate Research Professor in the Department of City and Regional Planning at the University of North Carolina at Chapel Hill. Dr. Smith also served as the Assistant Director for Hazard Mitigation in the State of North Carolina. During his tenure with the Division, the Mitigation Section administered mitigation and disaster recovery grant funds in excess of 1.5 billion dollars associated with 10 Presidential disaster declarations. Much of these funds were used to acquire and relocate or elevate over 5,000 and 500 homes respectively. Following Hurricane Floyd, Dr. Smith served as an advisor to Governor Hunt on policies and programs associated with long-term recovery in North Carolina. This work led to the development of 22 state programs (totaling 836 million dollars) that addressed local needs not met by federal assistance, including the development of the State's nationally recognized floodplain mapping initiative.

DR. ERIKA SVENDSEN is a research social scientist with the U.S. Forest Service in New York City. Her primary area of expertise is urban natural resource stewardship with a specific

focus on civic engagement, human well-being and governance. Her work is dedicated to cultivating diverse communities of knowledge and practice in order to improve the lives of people, strengthen communities and sustain our environment. Dr. Svendsen is part of the NYC Urban Field Station, a unique partnership between the U.S. Forest Service, NYC Department of Parks and Recreation and other community, academic and government partners. The Urban Field Station was created to improve quality of life in urban areas by conducting, supporting and fostering collaborative research about social-ecological systems and natural resource management. Dr. Svendsen is a recipient of 2007 EDRA/Places Award for Living Memorials National Research: 9-11 and the Public Landscape. She received the US Forest Service Chief's Award for her work in cities and the Early Career Scientist Research Station Award in recognition of STEW-MAP, a tool for mapping civic environmental action and managing ecosystem services in New York City. STEW-MAP teams have developed in Baltimore, Philadelphia, Chicago, Seattle, Los Angeles and San Juan. Recently, Dr. Svendsen has served as an advisor on MillionTreesNYC, Vibrant Cities Urban Forests, the US Forest Service Urban Field Station Network and DOI's Strategic Sciences Group. She is also a graduate of Yale FES '93.

DR. KEITH G. TIDBALL is a Senior Extension Associate in the Department of Natural Resources at Cornell University where he serves as Associate Director of the Civic Ecology Lab & Program Leader for the Nature & Human Security Program. He also represents Cornell as the New York State Coordinator for the NY Extension Disaster Education Network (NY EDEN) and as a program area leader for NYS Resiliency Institute for Storms and Emergencies (RISE). Tidball's research focuses on the dynamics of social-ecological resilience and natural resource management in disasters and war. He has recently published two books on the subject, and he is involved in multiple research projects funded by the US government agencies and private foundations. Tidball is a Fellow of the David R. Atkinson Center for a Sustainable Future and was recently appointed the 2014 USDA NIFA Division of Family and Consumer Sciences/Center for International Programs Visiting Scholar for his work with extension disaster education.

DANIEL ZARRILLI is the Director of Resiliency for the City of New York. Mayor Bloomberg appointed Daniel to this newly created position in June 2013 to lead the implementation of the City's PlaNYC resiliency report: A Stronger, More Resilient New York. Until June 2013, he served on the Mayor's Special Initiative for Rebuilding and Resiliency, leading the City's efforts to develop a comprehensive coastal protection plan for the five boroughs. In a previous role, he was the Senior Vice President for Asset Management at the New York City Economic Development Corporation (NYCEDC), responsible for maritime assets and operations, including the City's two cruise terminals and numerous other transportation and waterfront assets. Prior to joining NYCEDC, Daniel spent five years with Bechtel Infrastructure Corp. He is a Professional Engineer in the State of NY and holds an MS in Civil and Environmental Engineering from MIT and a BS in Civil Engineering from Lehigh University.