

BIOPHILIC CITIES

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SPECIAL ISSUE *The Urban Forest*

THE NATUREFUL CITY *Rediscovering Nature in a Pandemic Era / Tim Beatley*

FEATURE *Taking Stock: The First Step to Creating Healthier Cities With Trees / David Nowak*

ROOTS OF BIOPHILIC CITIES *Multitasking Street Trees / Sonja Dümpelmann*

PIONEER INTERVIEW *Jonathan Rose Companies / Mary-Michael Robertson*



The Biophilic Cities Journal is produced by Biophilic Cities, which partners with cities, scholars and advocates from across the globe to build an understanding of the value and contribution of nature in cities to the lives of urban residents. As a central element of its work, Biophilic Cities facilitates a global network of partner cities, organizations and individuals working collectively to pursue the vision of a natureful city within their unique and diverse environments and cultures. The participants in the network are working in concert to conserve and celebrate nature in all its forms and the many important ways in which cities and their inhabitants benefit from the biodiversity and wild urban spaces present in cities.

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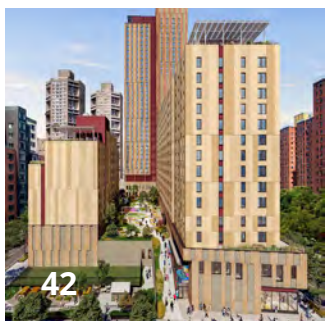
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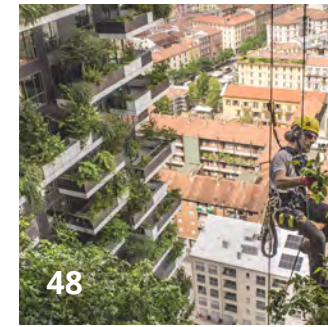
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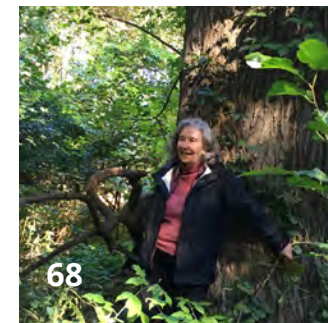


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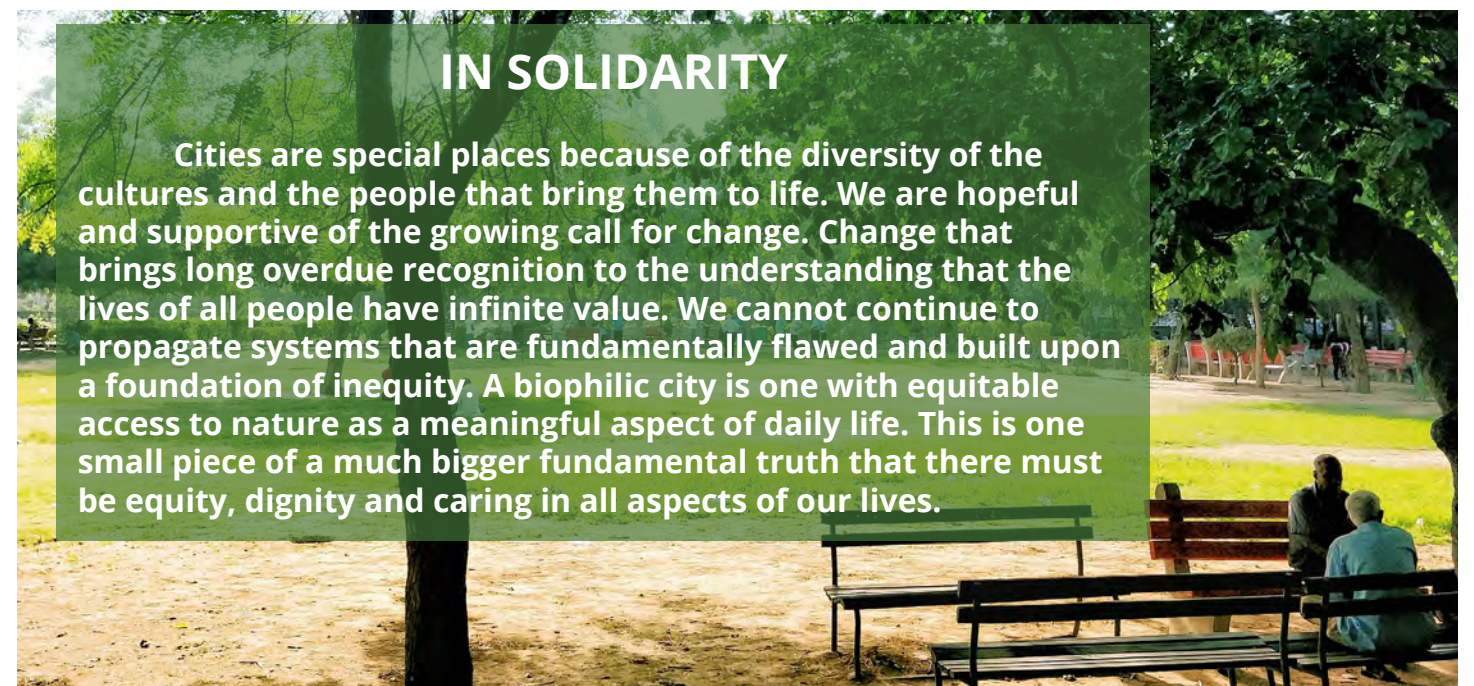
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IN SOLIDARITY

Cities are special places because of the diversity of the cultures and the people that bring them to life. We are hopeful and supportive of the growing call for change. Change that brings long overdue recognition to the understanding that the lives of all people have infinite value. We cannot continue to propagate systems that are fundamentally flawed and built upon a foundation of inequity. A biophilic city is one with equitable access to nature as a meaningful aspect of daily life. This is one small piece of a much bigger fundamental truth that there must be equity, dignity and caring in all aspects of our lives.



Photo Credit: Choi Ben

The Natureful City: Rediscovering Nature in a Pandemic Era

By Tim Beatley

I don't think any of us could have predicted where we are, collectively and individually, as we adapt to this terrifying global pandemic and the new realities that will exist after it is over.

Amongst the pain and suffering, and the shocking number of lives lost, we are all struggling for meaning and for silver linings where they exist. This search for a hopeful future is something that seems intrinsic to the human spirit. For me, there are many things to be impressed by during this pandemic, many selfless acts, many wise and cautious steps of committed public officials (in addition to actions more cavalier and unwise) that give hope and reaffirm a sense of our collective fate.

The importance of nature, and

the dramatic affirmation of its value in our daily lives, is for me perhaps the most striking thing about this challenging period. It is this sense of our collective desire to reconnect with the natural world and the essential balm and salve that nature provides to us. There has been a spike in bird-watching. More and more of us want to visit parks and beaches and to stroll through neighborhoods. We have undertaken a process of collective rediscovery of nature around our homes and in our neighborhoods.

Many of us have been planting vegetable gardens and native flowers in our yards. One of our professors here at UVA created a [makeshift church in his backyard](#) as a place to worship on Sundays. We have all returned

to worship at the altar of nature, in a way. I am hopeful that these tangible and meaningful acts of renewal and commitment will carry forward in important and meaningful ways.

There have been numerous reports of how nature has taken over spaces left unoccupied by humans. For many, this has provided some glimpse of what the world might look like without us, and for others it is practical and clear evidence of how quickly we might be able to rewild the spaces around us. The animals have always been there of course and our new observations are partly a result of having the time to watch and listen in ways that we have not in the past. Perhaps the sense of delight and surprise at the reappearance of wild nature

in our cities and communities can serve as a springboard for new efforts at coexistence with and conservation of urban biodiversity.

The pandemic has given another kind of connection as the usual noises of cars and planes and cities have, at least briefly, been muted. We are hearing things that we have not heard before or as clearly in some time -- birdsong to be sure, but also the sounds of rushing water in nearby streams and rivers, the rustling of trees, the natural background soundscapes of our cities that remind us that we are not alone and are a kind of natural music we should work to protect. It is the "subtlety of life around us," says soundscape ecologist Bernie Krause, in a [recent interview with NPR](#). At precisely the moment in history when we seem to be doing the most to destroy and

speed its unraveling, we are rediscovering nature as a steady and basic element in our lives unlike anything else. As the pandemic unfolded in North American spring, we found solace in the sight and sounds of birds and in the billions of our fellow soul mates doing what they have done for millennia, migrating and getting ready to reproduce and continue life that has existed for them since they evolved from dinosaurs.

I find many things to be thankful for during this period of lockdown, but many worries as well. In addition to the ability to see, hear and visit nature, I have the blessing of family to share these experiences. But I find myself wondering about the toll of social isolation and loneliness, something already on the rise before the pandemic. A [2018 Cigna study](#) (oft cited recently) found that nearly half of 20,000

respondents reported sometimes or always feeling alone or left out. I can only imagine the pain of isolation, especially for those without the ability to sit on a porch, plant flowers or visit with relatives. The high-mortality rate of the virus in nursing homes is one of the most depressing aspects of the pandemic: I can only imagine the sense of despair and loneliness that many residents, in the final days, experienced.

Another aspect of the natural experiment that we are in is our newfound competence as a species on Zoom. I am not convinced, despite our competence, that Zoom delivers anywhere near the level of connection we want and need and is certainly no antidote to isolation. Nature must surely be part of the answer of course, and I have begun thinking of the various critters that co-occupy my

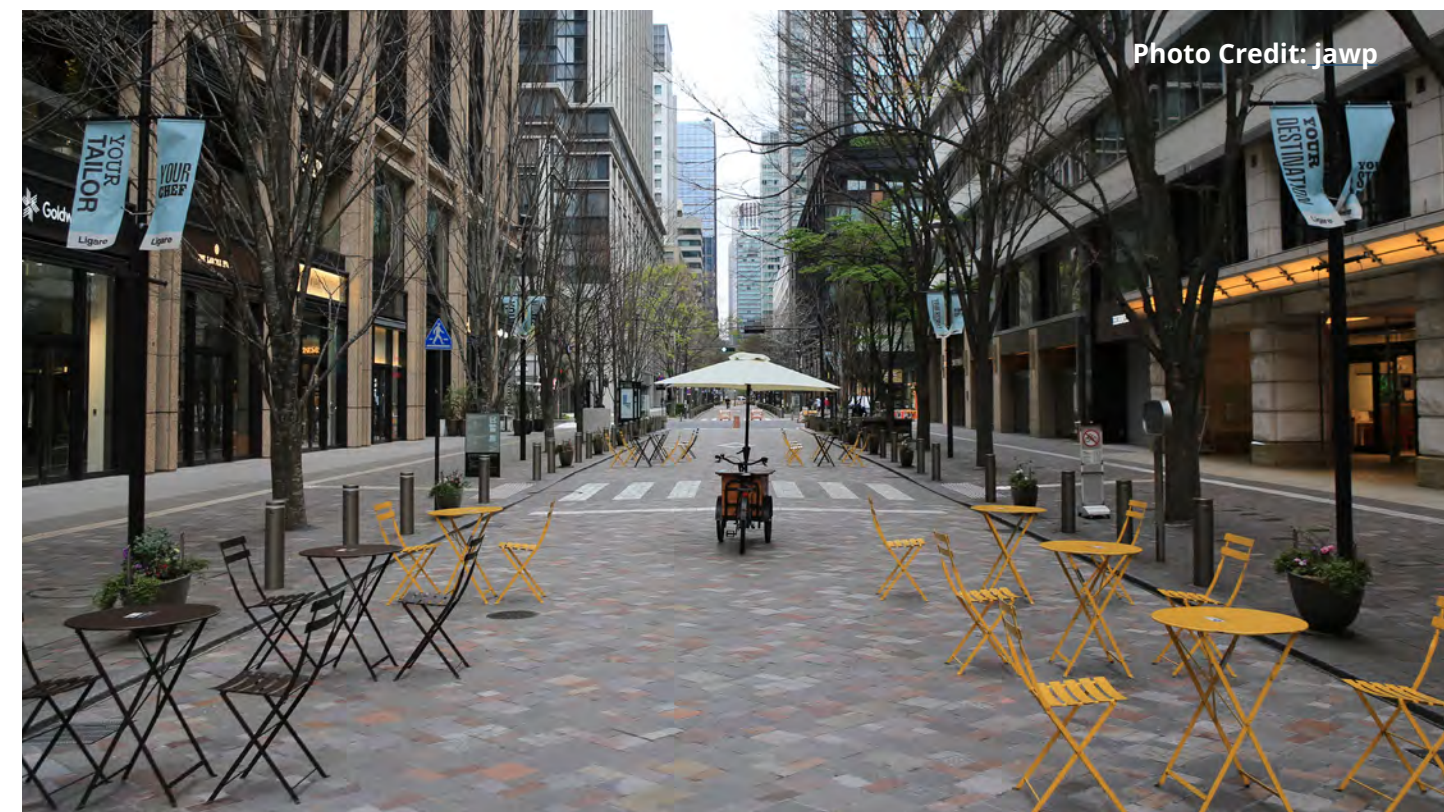


Photo Credit: jawp

Charlottesville space as members of the family: the chipmunks and squirrels, the occasional fox, and especially the birds. Several days ago, we watched with pride the arrival of a fledged bluebird chick, attended to warmly by her parents. We did nothing in fact to justify the pride but it was there along with a sense of wonder and beauty; one small moment of constancy in the otherwise chaotic lives we have been leading.

The importance of being able to see nature from the inside of our homes during lockdown, to be able to open windows, to spend time on a deck or balcony or a rooftop, as well as to bring more abundant nature inside, are important lessons as well. There has been a growing and useful discussion about how the pandemic will change the design of homes. More attention to natureful interior spaces is likely, as more people will continue to work from home after the pandemic ends (with a profound rethinking of office environments being another necessary result). The pandemic seems clearly to have [elevated the importance of biophilic design](#) generally and this has been heralded in a number of news articles as a trend that is gaining in strength.

Many local governments have admirably risen to the occasion by taking steps to open-up more public space for walking, biking and (with social distancing) some level of social interaction. There has been an exemplary level of openness and nimbleness in their planning responses. The many clever ways that local

governments are balancing public safety while ensuring contact with the world out of doors have been impressive: parks that accommodate one-way hiking and strolling; and the closing of streets to car traffic such as the closing of JFK Drive in Golden Gate Park in San Francisco and the creation of a network of 74 miles of slow streets in Oakland, along with the efforts of many other cities. Urban spaces everywhere it seems are being reallocated from cars and parking to strolling, new bikeways, and outdoor eating. Several cities have already announced that these changes will continue permanently after the pandemic subsides and we may be on the cusp of generational changes in the spatial priorities of cities. One of the key lessons from this time is the critical importance of a robust and diverse network of [urban trails](#), pathways, alleyways, streetparks and parklets, and as yet to be named informal spaces for being in and moving through cities. These are key ways to be outside and to be enjoying nature.

One of the indelible memories we may all carry with us from the pandemic were the [reports from Italy of the nightly balcony singing](#). An important way of connecting, and a response to the perils of loneliness to be sure, they made me appreciate and think a bit more about how those kinds of intermediate or edge spaces (balconies, front stoops and rooftops) help to bridge the inside and outside worlds and can be so essential in times like these. They are places to see and

be seen, to gaze at the lights below and beyond, to realize you are not alone, and hopefully to connect with the natural world through birdsong or the cultivation of gardens.

Another outcome of the pandemic has been a sense that we need major reforms to the supply lines that sustain us; indeed, the entire metabolism of our cities and communities needs reform. Shortages of eggs and flour have led to a resurgence of interest in backyard coops and local growers and producers. A highly dysfunctional, and quite inequitable, food supply became evidence as we saw (and see) unbelievably long lines at food banks on one hand and stacks of siloed potatoes and dumped milk on the other. There are already signs of change -- a sharp increase in CSA subscriptions is one, along with discussions everywhere about the need to protect farmland and [support struggling small farms](#).

The pandemic has demonstrated vividly the deep inequalities that exist in American societies as black and brown citizens have borne a disproportionate share of the burden -- experiencing greater vulnerability to the virus and dying at much higher rates than whites. The impact of pre-existing structural inequality and racism have been evident everywhere, including in the reality of fewer places to safely walk or bicycle in minority and lower income neighborhoods, fewer nearby parks and greenspaces to enjoy, fewer trees, and fewer resources overall with which to weather this crisis.



Greenmount West Mural, Baltimore
Photo Credit: Eli Pousson

Evidence has been mounting about the ways in which access to nature and the benefits of nature is impacted by long-standing discrimination. Several recently published papers have, for instance, come to similar conclusions about the lasting effects of redlining in our cities. [Lack of tree canopy cover is highly correlated with the redlining maps](#) of the HOLC (the federal Home Owners Lending Corporation), showing how these racist and discriminatory policies have had lasting effects, depriving communities of color of fair and equal access to nature.

In February, before the unfolding of the pandemic, I had the chance to participate in a wonderful conference organized by our colleagues at the Phipps Conservatory in Pittsburgh.

One of the most compelling presentations was by Kim Moore Bailey who heads the national nonprofit [Youth Outside](#). "Equitable access [to parks] is not enough," she told us. If the parks and green areas nearby are not welcoming, if you do not feel safe visiting them, then physical access or proximity is simply insufficient. If you are in fear of harassment or arrest or physical violence then what good is a nearby park?

These injustices were further highlighted by the George Floyd murder in Minneapolis in late May and the gut-wrenching protests that have swept up our country. It has been a moment of unusual clarity about the cumulative injustices experienced by communities of color. This history of racism and discrimination is interwoven

with enduring and present inequalities in the access to parks and nature and more generally to the safe and livable communities we all need, want and deserve. We will never truly reach the vision of biophilic cities without redressing these inequalities and the underlying racism behind them. We can must hope that change will result; but more, we must convert this hope into action.

In the months prior to the onset of the pandemic, we have seen our Biophilic Cities Network and community achieve some wonderful milestones. Many of us were able to travel in October to Singapore to participate in what was the first face-to-face meeting of the Network since its launch in 2013. We have had some wonderful new additions to the Network, including

Arlington County and the cities of Richmond and Norfolk. Each of these jurisdictions has a stellar record of connecting with nature and offering special lessons and insights.

Arlington has been a progressive leader when it comes to all things green, from bicycles to transit to green building. Notable in Arlington is a new [Public Spaces Master Plan](#) that includes specific reference to Biophilic Cities. The plan contains the important goals of strengthening the county's existing network of spaces along with creating new kinds of spaces, notably "casual use spaces" defined in the plan as "spaces that are intentionally designed to support casual, impromptu use and connection with nature" (precisely the kinds of spaces most needed during periods of lockdowns and

quarantines).

Richmond is unusual for its urban wildness, and its continuing efforts to connect residents to the James River. The innovative [James River Park System Master Plan](#) has led to new ways for residents to connect with water, including the new T. Tyler Potterfield Memorial Bridge for pedestrians and bikers. Norfolk similarly interacts with water and wildness in its existential need to plan for and adapt to coastal flooding and long-term sea level rise. Norfolk is a leader among cities seeking to accommodate sea level rise and has adopted a pioneering long-term plan and an innovative resilience-based zoning code to accomplish this. As this story unfolds, Norfolk will likely show how biophilic design and planning can at once help to strengthen connections to nature

and make a city more resilient.

How cities will change as we move beyond the global pandemic is hard to know, but I am hopeful that we use this period as a springboard to further renew our vows to nature. Again, the many steps that cities have taken (and are taking) to facilitate enjoyment of outdoor nature are impressive -- from designating slow streets in Oakland to new bicycle routes in Bogota to new car-free spaces in many cities, from London to Mumbai. There is a momentum here and level of attention to these issues that we must build upon. There is a growing sense, and resulting productive discussion, that to avoid future pandemics we will need to radically change our relationship with the natural world; global deforestation, biodiversity loss,

and of course climate change, can no longer be shrugged off. [Jane Goodall in an interview with PBS](#) spoke eloquently of the deeper lessons of how we must readjust our relationship with nature; how we must protect and cherish it, and work to curtail such things as animal trafficking and so-called wet markets that seem to be the primary source of such deadly viruses. The pandemic is a visceral and powerful demonstration of how we are all interconnected, she wisely says.

Combating a virus requires a coordinated international effort, but also so does climate change and biodiversity conservation. The bushfires in Australia seem a lifetime ago but also contributed to this sense of interconnection, as many of us grappled with the emotional and heartbreaking images of koalas, wallabies and other animals trying to escape the inferno. There was a sense of shared pain but also a sense of helplessness at things happening so far away and seemingly so far outside of our own control.

I am hopeful that the period of tumult we are in will strengthen our resolve for change. Cities especially will need to lead the way and the vision of biophilic cities is now more salient, relevant and compelling than ever before. The collective work will need include many steps to ensure abundant, nearby nature, and increasingly must be bolstered by actions that cities can take (politically, economically, and legally) to work to protect nature around the world. Part of this must involve efforts by

cities in the global north to take responsibility for the impact of their resource demands and large ecological footprints. Efforts at effectively blending and merging the agendas of global conservation with more local urban greening and biophilia will be critical moving forward.

Against the backdrop of the terror and depression these times evoke, is again the hopefulness of the many impressive things underway and the sense that change, in the direction of more natureful and just cities, is in the offing. In this issue, we shine a special spotlight on the efforts that concern trees in and near to cities. Few things in nature offer more hope, beauty and meaning than trees. And few things are as reassuring as gazing at a tree that has provided continuity, stability and commitment to the health of the larger community of life.

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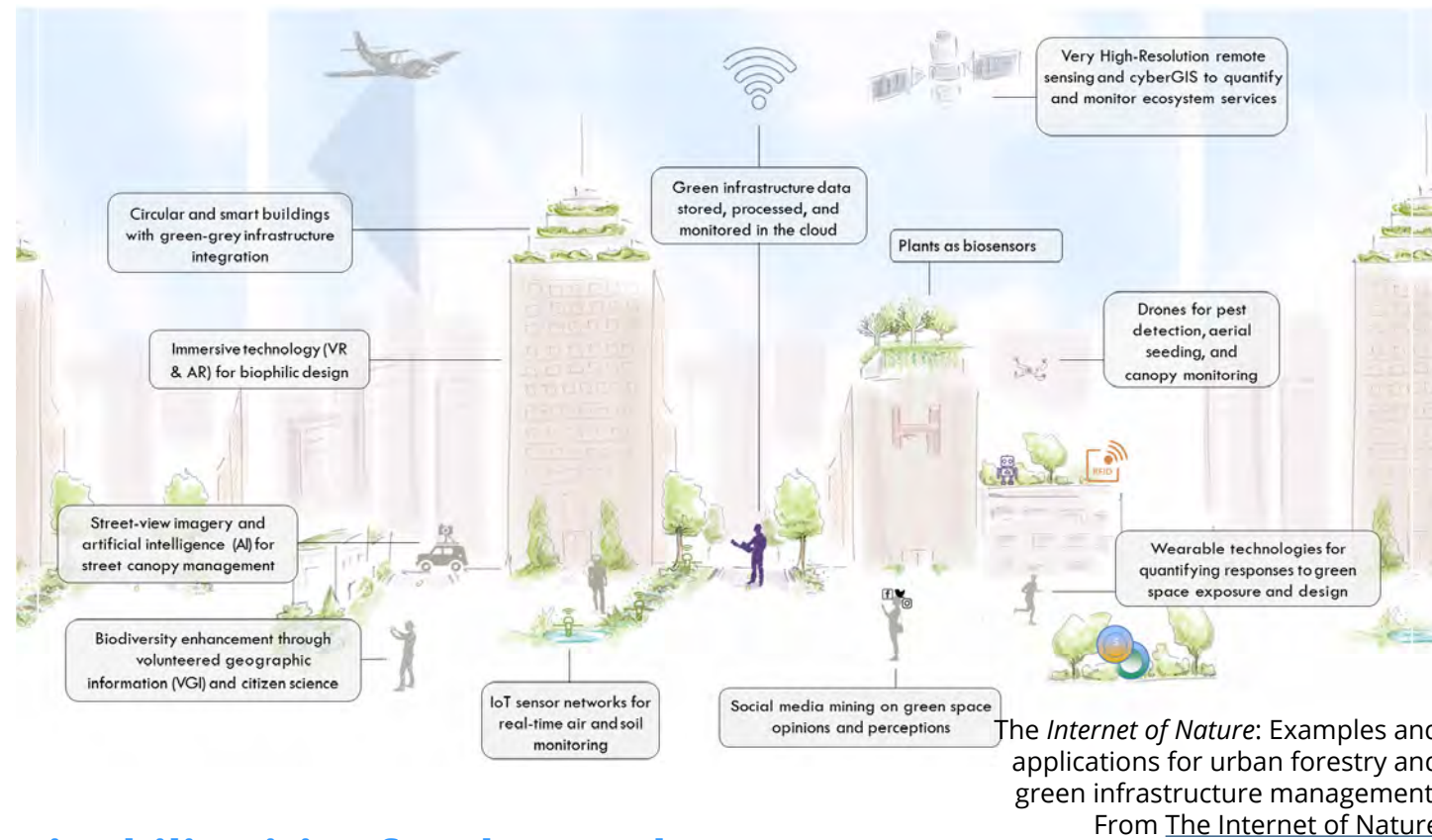
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T. Tyler Potterfield Memorial Bridge
Photo Credit: Nicholas Seitz



The *Internet of Nature*: Examples and applications for urban forestry and green infrastructure management. From *The Internet of Nature*

Biophilic Cities for the 22nd Century

By Nadinè Galle and Sophie Nitoslawski

Take nature online. It might sound crazy, but plugging nature into a city's existing (and growing) digital infrastructure—where urban ecosystems can be described and represented through technology—might be exactly what the world needs to build the biophilic cities of the future.

Introduction

We are living in an era of unprecedented growth in cities—the future is decidedly urban. Never before have so many people lived in cities, and of such great magnitude. The United Nations now predicts that the world will have 43 megacities (over 10 million people) by 2030. Three million people are not just moving to cities every single week—they are staying there for

the rest of their lives. These days, the entire life-cycle of human beings takes place in cities. In stark contrast to the savannas in which we evolved, the urban landscape is becoming the default biotope for humankind.

Urbanization at this scale requires a broad and systemic redesign. Nature is already illustrating how extreme and novel cities (or “urban ecosystems”) have become, mostly through the phenomenon of “urban evolution”. Urbanization, defined as the alteration of natural habitat into a landscape primarily consisting of gray infrastructure such as buildings, roads, and other human-engineered amenities, results in other abiotic changes, such as

increased pollution, altered light patterns due to artificial light production, growing impervious surface area, and the introduction of “human” foods and waste.

Urban animals and plants are evolving accordingly. In *Darwin Comes to Town: How the Urban Jungle Drives Evolution*, Dr. Menno Schilthuis aptly describes how pigeons develop detox-plumage to protect against lower air quality, while blackbirds sing at a higher pitch to ensure detection over noisy traffic (Nemeth & Brumm 2009). Weeds growing out of cracks in the pavement produce heavy, compact seeds designed to drop close to the plant and promote reproduction, a change which evolved over a period of just 12 years (Cheptou

et al. 2008). Evolution at this temporal scale is in stark contrast to the Darwinian notion that evolution could never be seen in a single lifetime. Schilthuis (2018) proves that these organisms are on their way to becoming entirely novel, and very urban, species. These examples illustrate the now extreme conditions of city environments, and the complexities involved when working with nature in an urban age.

Urban Nature's Benefits and Services

Interest in biophilic cities has reached a turning point, and rightly so. Many urban dwellers are sweltering under extreme heat events, suffocating due to poor air quality, and buckling under immense mental stress that may in part be attributed to the urban environment. People in cities spend as much as 90% of their lives indoors, and when people do go outside, it typically occurs within urban

areas (Custovic, Taggart & Woodcock 1994; Hoppe & Martinac 1998). More and more, the urban nature and green infrastructure in cities is being called upon to play a crucial role in climate change adaptation and mitigation. Studies highlight the contributions of urban nature to all facets of urban life. Also known as ecosystem services (ES), these benefits enhance quality of life and contribute to human well-being. Now a commonly-understood term in urban ecology, ES provides “a

THE VALUE OF NATURE IN URBAN LIFE

Nature provides diverse life-supporting and life-enhancing contributions to people in cities and towns. These gifts from nature make human life both possible and worth living. All cities critically depend on healthy interconnected ecosystems within and around them, so it is essential that nature is fully integrated into urban planning and development. There is a growing urgency for collective and large-scale action to protect the biodiversity in and around cities to prevent irreversible loss and damage to the natural systems we depend on.

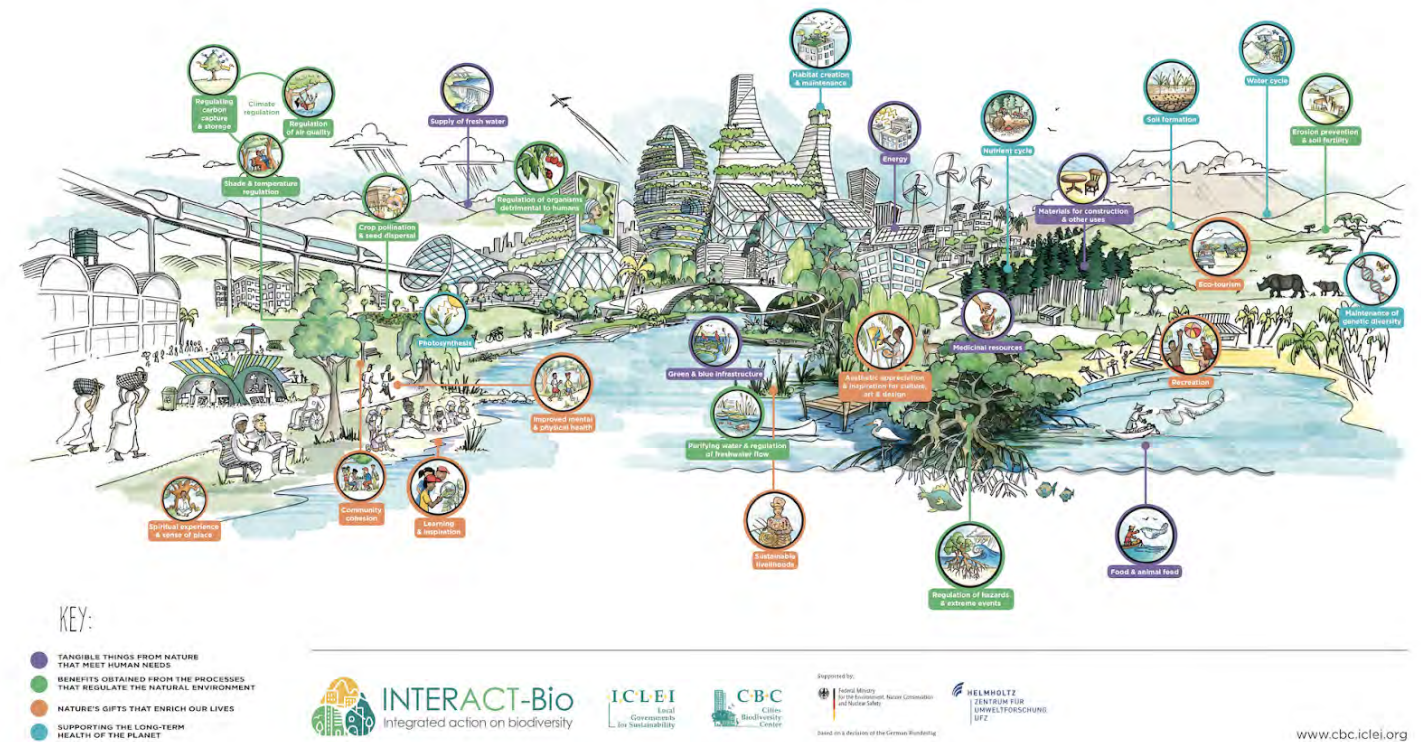


Figure: Nature provides many diverse life-supporting and life-enhancing contributions to people in cities and their surrounding regions (ICLEI, 2018).

The Value of Nature in Urban Life poster was produced as a part of the INTERACT-Bio project. INTERACT-Bio is implemented by ICLEI - Local Governments for Sustainability and supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative (IKI).

framework for conceptualizing and managing human–environmental interactions” (Daily et al. 2009), elevating the importance of urban nature in urban sustainability discourses.

Urban nature provides a suite of ES and co-benefits compared to more traditional gray infrastructure (Duinker et al. 2015). Broadly speaking, the ecological benefits of urban nature relate to wildlife habitat, biodiversity protection and conservation, improved water and air quality, stormwater management, cooling and shade provisioning, and carbon storage. From an economic perspective, trees promote local economic activity and development and, in some cases, increase property values and contribute to energy savings. At the societal and cultural level, urban green infrastructure contributes to general well-being, promotes tourism and recreational activities, provides educational opportunities, and can enhance community safety. Urban nature is increasingly recognized as an important social determinant of health, with the potential to restore and positively contribute to mental health. Trees in particular are a vital component of urban green infrastructure; they are special and unique in that “they predominate in contributing to the vertical dimension of the plant community on account of their height,” playing a significant role in heightening the visual experience of urban dwellers (Duinker et al. 2015, p. 7380).

Unfortunately, ecosystem services are not necessarily evenly distributed across cities. Issues of green equity have gained prominence in urban planning, as some research shows that neighborhoods associated with lower socio-economic outcomes have reduced access to high-quality green spaces (Nesbitt et al. 2019). Lower-income and marginalized communities are often disproportionately impacted by climate-related events, which can be mitigated through tree canopy enhancement. More recent research has elucidated relationships between maternal exposure to green space and infant birth weight (Cusack et al. 2018), highlighting the long-term significance of working towards accessible and equitable delivery of green benefits.

Furthermore, many urban forests and associated green spaces are frequently degraded due to lack of resources and capacity for maintenance, conflicts with gray infrastructure, and abiotic stresses common to urban environments. Soil compaction, urban heat islands, overhead utility wires, communication and gas lines, construction and demand for housing, election cycles, and budget allocation prove challenging to varying degrees when managing urban green infrastructure. The lack of consistent, reliable, and precise data on urban forests and green spaces is also a common theme across municipalities, hindering proactive decision-making. The piloting and implementation of novel practices for monitoring green infrastructure are thus

sorely needed to unearth uniquely urban interactions, and improve the delivery of ecosystem services that benefit the lives of urban dwellers everywhere.

The Internet of Nature (IoN)

Enter the “Internet of Nature” (IoN): a new approach to urban ecosystem management where individual parts of an ecosystem can be described and represented through digital technologies and applications, allowing us to unearth synergies between components and enhance resilience in urban ecosystems (Galle et al. 2019).

In a forest, trees “talk” via mycorrhizal fungi that colonize the plant’s root system and develop a symbiotic association called “mycorrhiza” (from the Greek *mukés*, meaning fungus, and *rhiza*, meaning roots) (Das 2015). These fungi have existed since the first plants appeared on dry land more than 450 million years ago. Mycorrhizae work by forming a network of very tiny, almost microscopic, threads called “hyphae.” These networks allow for biological communication, in which nutrients, water, CO₂, and even information (e.g. defense signals about pests and disease) are exchanged.

These microbes are essential for healthy soil, and in turn, a healthy urban ecosystem. However, these fungal networks which have kept forests and plant systems self-regulating and self-sufficient for hundreds of millions of years are highly fragmented in cities. There

is compelling evidence showing urban trees struggle compared to their rural counterparts. Bainard, Klironomos & Gordon (2011) found urban environments have lower microbial activity and diversity compared to rural or natural ecosystems, while Roman & Scatena (2011) found urban forestry literature frequently reports high mortality rates and low average lifespans for street trees.

With the increasing recognition that green and naturalized spaces are crucial to urban design, coupled with the rapid and widespread utilization of data and digital technologies for municipal decision-making, what if technology could step in where Earth’s biological communication networks have been altered and disrupted? The IoN, or a city’s bio-technological communication network, could be the innovative approach needed to better value, understand, and manage these novel ecosystems.

Applying the IoN, Across the World

From sensor networks for real-time soil monitoring, to mining social media for public opinion on green spaces, to drones for pest detection, to remote sensing for ecosystem services analysis, the IoN can be applied in several different ways. The idea is to digitally represent aspects of urban nature, and connect it to wider city communication networks and systems. When several of these pieces act in unison, we are able to collect “ecosystem intelligence,” where information and data obtained

The Internet of Nature is where urban ecosystem components and interrelation dynamics are described and represented through digital technologies and applications. These may include, but are not limited to, information and communications technology (ICT), remote sensing, machine learning, sensors and data loggers, 5G communications and advanced computing. In this representation, the benefits of urban nature are enhanced and self-organization, self-regulation, and automation can be achieved.

Ecosystem Intelligence refers to information and data obtained from the digital representation of these urban ecosystems, which can be used to inform management and planning decisions. The ultimate goal of elucidating ecosystem intelligence is to understand the “language” or urban ecosystem elements, and determine how ecosystem components interact in a city’s social-ecological landscape.

Urban Nature		Urban Technol-	
Green Infrastructure	The collection of natural vegetation, soils, and bioengineered solutions that collectively provide society with a broad array of products and services for healthy living.	Augmented Reality (AR) and Virtual Reality (VR)	VR is a complete immersive experience meant to simulate real or fantasy-based environments. AR is where the real environment is enhanced with computer-generated, virtual objects, often for visualization purposes.
Ecosystem Services	The suite of benefits that humans freely gain from natural and semi-natural environments, especially from functioning ecosystems.	Artificial Intelligence	The simulation of human intelligence processes by computer systems, in order to perform tasks (e.g. decision-making) normally requiring human intelligence.
Urban Forests	A specific type of green infrastructure, defined as all woody and associated vegetation found in an urban setting.	Big Data	Extremely large data sets that may be analyzed to reveal patterns, trends, and associations, and that are often too complex to be dealt with using traditional methods.
		Internet of Things (IoT)	The extension of the internet to a range of objects, processes, and environments.

from the digital representation of these urban ecosystems can be used to inform management and planning decisions. The ultimate goal of elucidating ecosystem intelligence is to understand the “language” of urban ecosystem elements, and determine how these interact in the urban landscape. This is critical when large amounts of data are needed to model and predict

urban stresses and impacts. For the purposes of this article, we look at how the IoN, and by extension, emerging technologies, can actually bring people closer to the goal of biophilic cities. Biophilic (from bio-, referring to “life”, and philia, meaning “love”) cities are not, by definition, anti-technology. In fact, the IoN does not serve to replicate the natural world

with technology at all, but rather to utilize technology to improve urban environmental management. This article explores how the emerging technologies put forward by the IoN hold the potential to revolutionize urban ecology. We draw on four global case studies to understand how the IoN is being applied, right now.

biophilic landscape design’s true dimensions and aesthetics with a sense of perspective, which is otherwise impossible until the landscape is built, planted and mature. VR and AR models can also be created with varying levels of animation, interactivity and soundscapes to create an accurate impression of a biophilic development or landscape.

For example, AECOM created 3D models and animations as part of a feasibility study for a green footbridge. These models can then be integrated into VR applications to enable users to fully experience how the concept would seamlessly integrate into the surrounding landscape (Figure 3). Using immersive technology to benefit

urban habitat design is still very much in its infancy. However, its value in engaging stakeholders and the general public with the consultation process is clear, particularly as research shows VR can make people more sympathetic towards causes (Ahn et al. 2014).



Immersive Technology for Biophilic Design

By Ash Welch, AECOM

Biophilic cities and design are intricately interconnected. If biophilic cities describe places where people have an innate love for, attachment to, and even need for nature, then biophilic design must necessarily promote connection to the natural environment. We asked senior Green Infrastructure & Biodiversity Specialist at AECOM, Ash Welch, to illustrate how immersive technology can play a role in biophilic design.

Immersive technology, such as virtual reality (VR) and augmented reality (AR), is steadily becoming commonplace within mainstream applications. While its entertainment uses are obvious, there are also opportunities to deploy

this technology to aid green infrastructure design – for example, using 3D illustrations and VR to create realistic-looking models. By making it easier to see how design changes will look, this approach can improve collaboration and efficient working between engineers, ecologists and other disciplines. This was particularly pertinent for AECOM in designing a biodiverse rooftop terrace for Adastra House in London, [in which VR was used](#) to complement solar photovoltaics and greenery but also to encourage the client to fully implement AECOM’s habitat recommendations (Figure 2).

Visualizing and experiencing green infrastructure design is a powerful method of communication. It allows clients, stakeholders and the general public to experience a

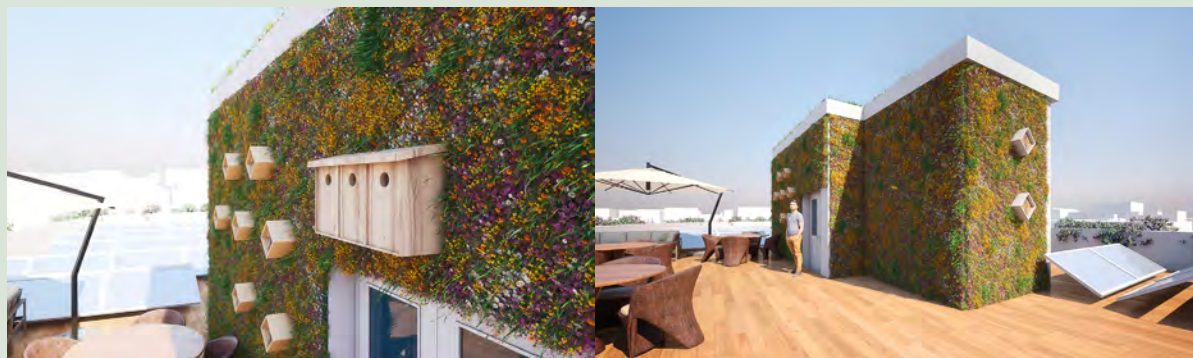


Figure 2: The Adastra House, a biophilic rooftop terrace on a residential apartment block in North London.



Figure 3: A38 Green footbridge feasibility study concept design for Highways England.

Very High Resolution Remote Sensing for Urban Tree Inventories

Evidence continues to show that urban forests and other green spaces are paramount to urban liveability. However, monitoring and management of these socio-ecological systems continues to challenge many municipalities, particularly those constrained by lack of resources and capacity. Tree inventories are a start to making sense of urban forest complexity by itemizing the species, size, age, location, and condition of trees. Inventories produce crucial information on the health and diversity of the urban forest, and are a necessity

for effective planning. Tree inventories are, for the most part, completed via manual field surveying, where an arborist will use a checklist or mobile app-based software to record key metrics on each tree. Surveying has its fair share of disadvantages: it’s expensive to conduct, laborious to update regularly, and based on observation-based estimations, leading to errors and concerns about data quality (Roman et al. 2017). Furthermore, many tree inventories are incomplete as they only include publicly-owned trees, when in many cities, over half of the trees are on private lands (Jacobs, Mikhailovich & Delaney 2014; Nowak &

Greenfield 2012). Despite being on private land, these trees still offer significant community benefits, and cities have an increasingly vested interest in tracking their status.

Very high resolution (VHR) satellite imagery can help. Ever since the 1972 launch of the Earth Resources Technology Satellite (Landsat 1), remote sensing has been increasingly applied to monitor Earth’s ecosystems. With the technological improvements of satellite sensors and machine learning algorithms, we have reached a new application epoch of Earth observation.

[Green City Watch](#), a geospatial artificial intelligence (geoAI) firm specialized in urban ecological engineering, is developing TreeTect™, which inventories all public and private urban trees in a given city, and monitors these in near real-time (Figure 4). TreeTect™ utilizes satellite imagery, computer vision, and machine

learning to pinpoint individual tree species, size, location, and condition. The growing space conflicts of the tree can then be estimated. In practice, an inventory like this could mitigate liabilities by continuously tracking tree condition and maintenance needs, justify budgets by visualizing impact of underfunded and reactive

planting, maintenance and removal protocols, and enhance urban forests by identifying illegal tree removal and locating vacant planting areas. All in all, TreeTect™ can help minimize labor-intensive, expensive field surveying—offering a novel application to enhance efficiency and decision making in urban forestry.

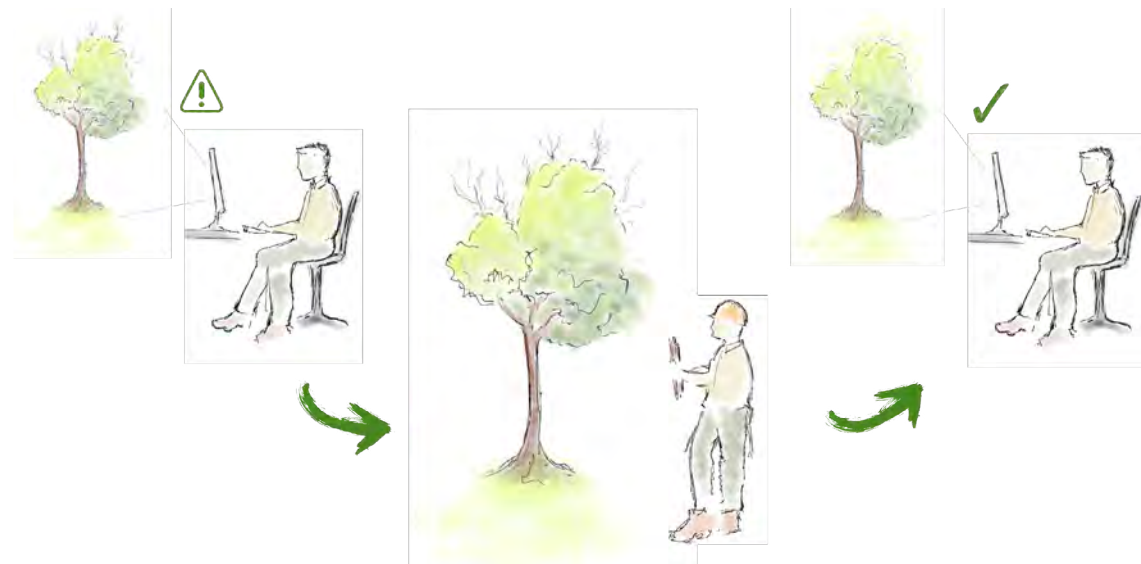


Figure 4: TreeTect™ by Green City Watch, offers city arborists and planners a smarter way to identify, map, and track one of their most important assets: trees.

Google Street View to Quantify the Street Canopy

By Carlo Ratti and Fábio Duarte, MIT Senseable City Lab

What might biophilic cities look like from the street? Carlo Ratti and Fabio Duarte, director and research scientist of the Senseable City Lab at the Massachusetts Institute of Technology (MIT), respectively, explain that using data-driven technologies to better understand urban nature holds massive potential.



Since Google Street View (GSV) was launched in 2007, its cars have been collecting millions of photographs in hundreds of cities around the world. In New York City (USA) alone, there are about 100,000 sampling points, with six photographs captured in each of



them, totaling 600,000 images. In London (UK), this number reaches 1 million images. The GSV fleet now also includes bicycles, trolleys (for indoor spaces), snowmobiles, and “trekkers” (for areas inaccessible by other modes). Such an overwhelming

abundance of images becomes increasingly interesting when we consider them as a rich source of urban information. At the Massachusetts Institute of Technology (MIT) Senseable City Lab, using large GSV datasets composed of hundreds of thousands of images per city, Li et al. (2015) and Seiferling et al. (2017) calculated the percentage of green vegetation in streets, using computer vision techniques to detect green pixels in each image and subtract geometric

shapes (Figure 5). With a few computational steps, what is left from this subtraction is greenery. Since the GSV data acquisition procedure is standard, these methods enable the calculation of street greenery in dozens of cities around the world and to compare them—using what they call the “Green View Index”.

Using computer vision and machine learning techniques to analyze ‘big data’ datasets of GSV

images helped to understand urban features in ways that would take too long or be financially prohibitive for most cities using human-based or other technological methods. By using GSV data with computer vision techniques, MIT Senseable City Lab demonstrated the value of bringing ‘big data’ to the human level, to the tangible aspects of urban life.

IoT Sensors for Soil Health

By Didy Arnold, Treemania

Compaction, construction, and pollution—urban soils face a myriad of anthropogenic pressures. The role of soil, along with biological and microbial activity, is relatively understudied in urban forest landscapes (Herrmann et al. 2018). Biologist and Co-Founder of Treemania, Didy Arnold, tells us how technology and IoT can help monitor interactions between urban trees and soil.



Treemania is a Dutch startup that focuses on greening cities and making agriculture more sustainable. Aboveground, Treemania engineers ideal growing conditions using a combination of plants that act as natural enemies for the most common pests and diseases for planted trees. By planting a diversity of tree species, the chance of infection greatly diminishes. When choosing tree

Diversity of tree species, the chance of infection greatly diminishes. When choosing tree species and finalizing designs, ecosystem services such as stormwater regulation, shade and cooling, carbon sequestration and storage, and air quality improvements are taken into account.

Achieving a healthy soil filled with organisms, both large and

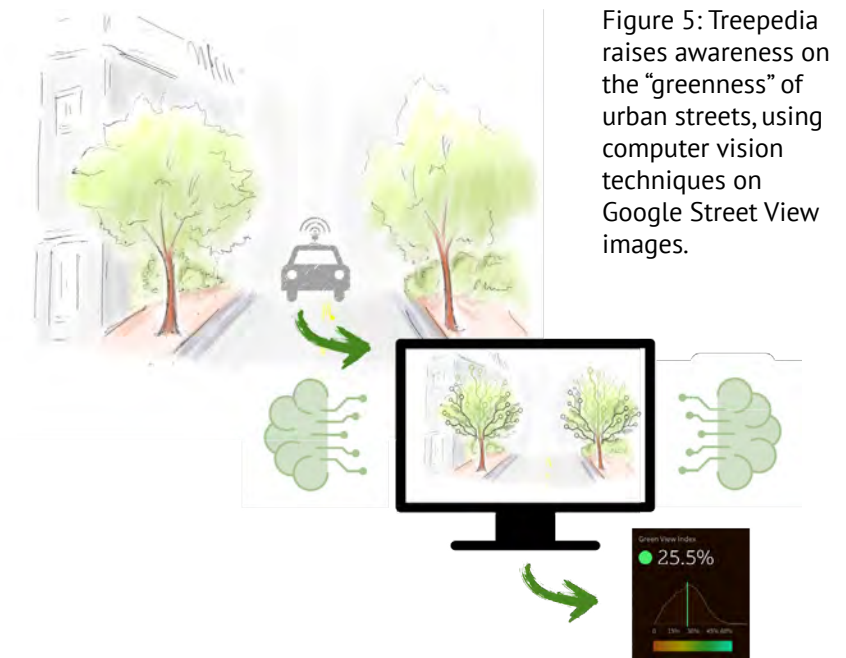


Figure 5: Treepedia raises awareness on the “greenness” of urban streets, using computer vision techniques on Google Street View images.

small, forms the basis for all of Tremania's projects. Urban trees are detached from one another in such a way that it prevents mutual root contact and hinders fungi and bacteria symbiosis. To monitor the developments in the soil and to be sure that newly planted trees have sufficient moisture and nutrients at their disposal, Tremania uses sensors. With sensors, soil moisture is measured in real-time, as this is essential for both the tree and the life in the soil.

At quick glance, on their dashboard, tree care providers can now see how much water

newly planted trees need to thrive. New trees and shrubs need regular and consistent watering until root systems establish. Lack of establishment due to lack of water is the most common reason for failure in the first three years of planting. By measuring soil electrical conductivity (EC), or the amount of salts in soil (salinity of soil), trees can be saved from salinized soils due to run-off road salt. Tremania has also developed a sensor to monitor whether the environment in the root zone is favorable for the development of the correct organisms that feed the plants and convert organic material into the soil. If necessary,

improvement measures can be implemented based on this data, keeping trees healthy and mitigating vulnerability to pests and disease.

Tremania's dashboard can also engage citizens and involve residents in "their" neighborhood greenery. For example, the residents of Geijsteren, a small village in the east of the Netherlands, can follow the condition of "their" Linden trees on a screen in the local cafe. When the trees are thirsty, the residents can take action and follow the progress on the screen, together.

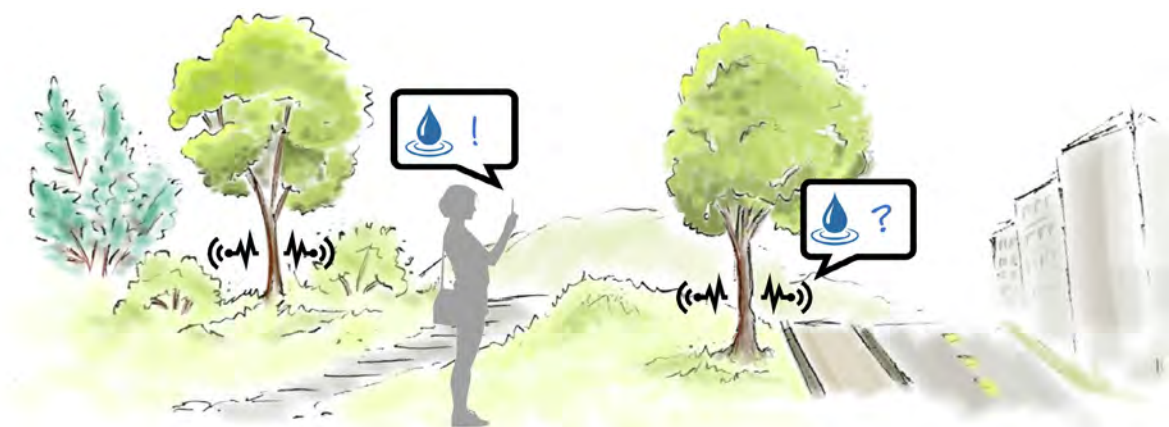


Figure 6: Tremania raises the alarm when soil is facing water shortage and other life-threatening conditions for trees.

Conclusion

In an increasingly digital society, intersections between urban nature and technology will become more prominent. The urban challenges that we face, such as pollution, climate-related events, population growth and immigration, and economic and social inequalities, call for innovative approaches to valuing and managing our urban natural capital. As nations urbanize and as cities grow, we need to ensure that practitioners have the resources to make proactive

and informed decisions about trees and green spaces, to provide green benefits that are accessible and shared by all.

Whether the IoN is applied to directly improve people's relationships with nature, or better the quality of urban nature for people to enjoy and benefit from, technology can play an important role in designing, managing, and connecting our urban green spaces. With this in mind, the gathering of ecosystem intelligence will require

standardized and transparent data stewardship. Moving forward, it will be essential to ensure that applications of the IoN promote accessibility and transparency, without compromising citizen and municipal rights. Ultimately, the IoN should offer a newfound ability to understand and respond to the needs of urban ecosystems—to monitor and manage, enhance ecosystem function and resilience, and link the complex social and ecological systems that make up our cities.



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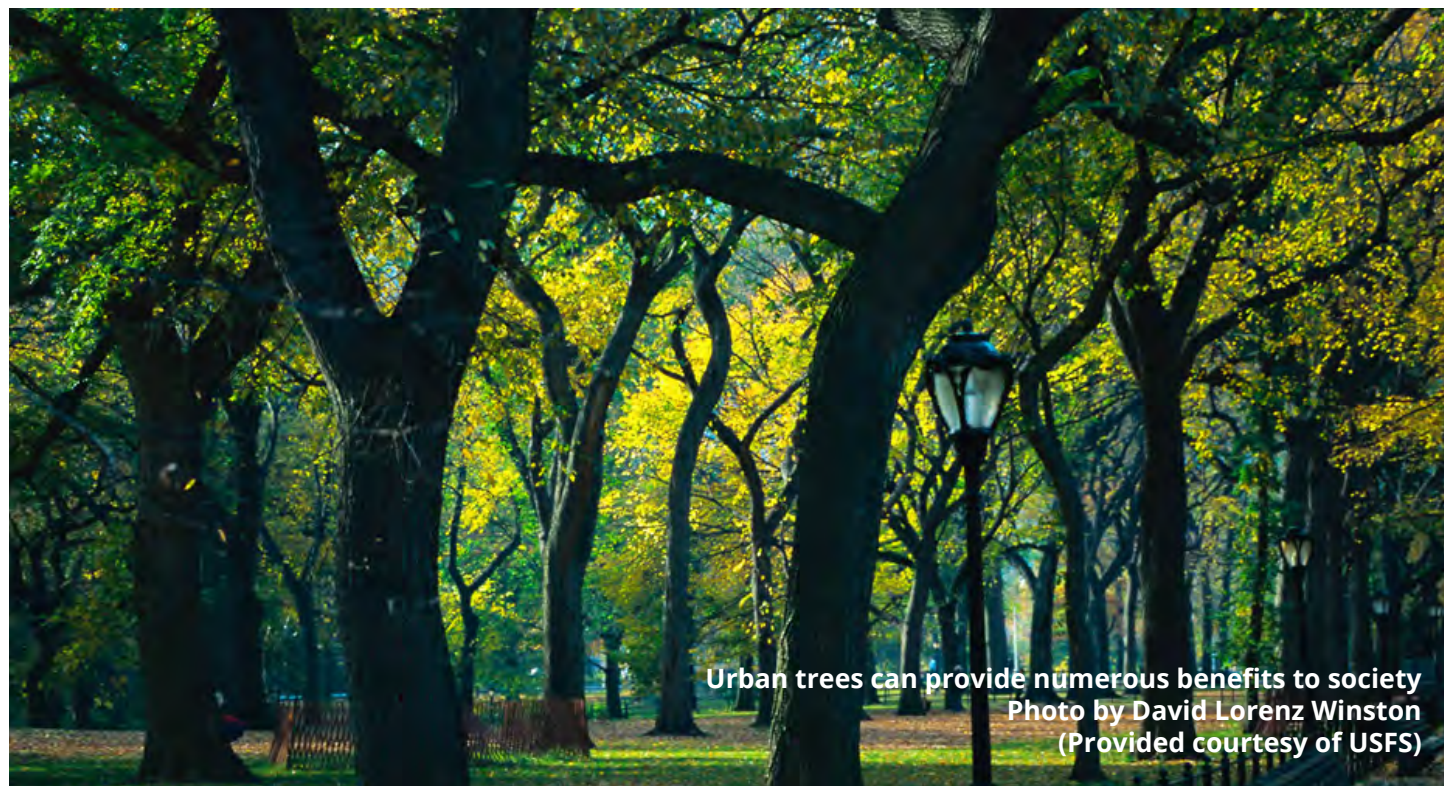
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Urban trees can provide numerous benefits to society
Photo by David Lorenz Winston
(Provided courtesy of USFS)

Taking Stock: The First Step to Creating Healthier Cities with Trees

By David Nowak, USDA Forest Service

With 55% of the world's population living in urban areas, which average 26.5% tree cover, trees are important landscape elements in most cities. Globally, tree cover varies from around 31% in forested regions, to 19% in grassland regions, to 13% in desert areas. Thus, because they are a significant component of all city landscapes to varying degrees, trees are important elements that will affect the health and well-being of local city residents.

City trees provide numerous benefits to society that include cooling air temperatures, reducing building energy use and atmospheric carbon dioxide (CO₂), improving air and water quality, mitigating rainfall runoff and flooding, enhancing human health and social well-being

and lowering noise impacts. In the United States, urban areas contain an estimated 5.5 billion trees that cover 39.4% of urban areas. These trees conservatively produce over \$18.3 billion in value annually due to air pollution removal (\$5.4 billion), reduced building energy use (\$5.4 billion), carbon sequestration (\$4.8 billion) and avoided pollutant emissions (\$2.7 billion). Numerous other benefits (e.g., improved psychological health, higher real estate values, noise reduction, etc.) remain to be quantified.

Urban forests also have various costs associated with tree planting, maintenance and removal, and other indirect costs such as allergies from tree pollen, increases in winter building energy use due to tree

shade from both evergreen and deciduous trees, and changes in local biodiversity due to invasive or exotic plants. While urban trees remove air pollution and reduce pollution concentrations overall, in some cases tree cover that overarches roadways can limit pollution dispersion and increase local pollution concentrations. Understanding the cost and benefits related to urban trees can lead to better designs to improve the urban environment with trees.

Changing City Tree Populations

The importance of urban trees and forests will increase in the coming years as urban populations increase and urban land expands. Global urban populations are expected to increase another 2.5 billion by

2050, increasing the proportion of the global urban population to 68%. Urban land in the United States is projected to increase from 3.6% (67.6 million acres) in 2010 to 8.6% (163.1 million acres) in 2060. This projected increase of 95.5 million acres is an increase in urban land larger than the state of Montana. While urban land and populations are expanding, the percent tree cover within existing urban areas is on the decline in recent years. Within existing urban areas, the average global urban tree cover had a slight, but statistically significant decline from 26.7% to 26.5% (c. 2012-2017), or a loss of about 100,000 acres per year. Concurrent with tree loss on urban land was an increase in impervious cover among all continents, which globally had a statistically significant increase from 24.3% to 25.9% (800,000 ac/year). In the United States, urban tree cover dropped by one

percent between 2009-2014 (40.4% to 39.4%), which equates to a loss of about 28.5 million trees per year. Estimated loss of benefits from trees in urban areas is conservatively valued at \$96 million per year. Urban impervious cover in the U.S. had a statistically significant increase from 25.6 percent to 26.6 percent (+1.0 percent), which equates to an annual increase of 131,000 acres of impervious cover per year.

Factors Influencing Urban Tree Populations

Various factors affect the amount, type and changes in tree cover within cities. Numerous forces can decrease tree cover, including development, insects and diseases, fire, climate change, storms, old age (natural tree attrition) and tree removal due to perceived risks to humans. Various factors can also increase tree cover, including tree

planting, but more importantly natural regeneration. As 75% of the world's urban population lives in forested regions that have ample precipitation and seed sources, natural regeneration can dominate the influx of new trees. In the US and Canada, about 2 in 3 trees in cities come from natural regeneration. The percentage of the tree population planted is greater in managed land uses (e.g., residential) and in cities developed in grassland vs. forested areas; the percentage of trees planted also tends to increase with increased population density and percent impervious cover in cities.

Dominant factors affecting the amount of urban tree cover are the surrounding natural environment (i.e., water availability, seed sources), population density and associated impervious surfaces that limit regeneration, and



Urban forest design is important to minimize potential negative effects, such as trapping pollutants near roadways
Photo Credit: David Nowak

management activities (e.g., mowing, which limits natural regeneration, and tree planting).

Assessing Local Urban Tree Populations and Values

Given the numerous factors that affect and change urban forests, it is important to understand local urban forest composition and impacts to effectively manage this resource to improve human health and well-being in cities. Although city managers know they have trees, without rudimentary information about this resource, it cannot be adequately managed and sustained. City managers often know how many people, cars, buildings, light poles, etc., that

they have, but have limited to no information on their vegetation resource. As these forests provide millions of dollars of benefits at the local scale, investment in a better understanding of this resource is paramount. The first step to understand this resource is taking stock of the current resource and its values. Managing a city without understanding its tree resource, which on average occupies one-quarter of the city area, is like managing a grocery store without knowing what is on one-quarter of the grocery store shelves. Basic stock, or inventory, information is essential to better management and developing plans to optimize forest values for current and future

generations.

To this end, the USDA Forest Service, the Davey Tree Expert Company and several partners have developed i-Tree (www.itreetools.org), a suite of free tools that aid in easily quantifying local urban forest structure and values. These tools provide information on forest structure that aids managers by revealing species composition, sizes, locations and potential forest risks (e.g. insects and diseases) as well as information on numerous services, costs and values (Table 1). Assessments can be conducted using field or aerial-based data. i-Tree is based on peer-reviewed science and has more than 410,000 users in 130 countries.

The core program of the i-Tree suite is i-Tree Eco. This model, which can be used globally, uses field-based sample or inventory data and local environmental data to assess and forecast forest structure, benefits, threats and values for any tree population. i-Tree Eco includes: plot selection tools; mobile data entry applications; tabular and graphic reporting and exporting; and automatic written report generation.

Remeasuring field and aerial data through time also provides a means to monitor changes in local urban forest resources and values. In the United States, the USDA Forest Service Forest's [Urban Forest Inventory and Analysis Program](#) is measuring urban forest data annually and uses i-Tree to assess current stock and changes in structure, services and values through time. Thirty-five cities were monitored in 2019 with new cities to be added to the monitoring program annually. Assessing both current stock and changes in stock through time are essential to sustaining adequate and healthy urban forests in the future.

The i-Tree tools have been used to aid forest management plans, assess risks, justify tree planting programs, protect urban tree resources, and justify financial support for urban forestry programs. These tools make it easy for everyone to assess their local urban forest resource and its value, which is the key first step to creating healthier cities with trees.



Other i-Tree tools include:

- **i-Tree Species** – selects the most appropriate tree species based on desired environmental functions and geographic area;
- **i-Tree Hydro*** – simulates the effects of changes in tree cover and impervious cover on runoff, stream flow and water quality;
- **i-Tree Canopy*** – allows users to easily photo-interpret Google aerial images to produce statistical estimates of land cover types (historical imagery in Google Earth can also be used in analyzing changes in land-cover types);
- **i-Tree Design** – links to Google Maps and enables users to quantify the current and future benefits of trees on their properties;
- **MyTree** – easily assesses the benefits of one to a few trees using a phone via a mobile web browser; and
- **i-Tree Landscape** – allows users to explore tree canopy, land cover, tree benefits, forest and health risks, and basic demographic information anywhere in the United States and to prioritize areas for tree planting and protection.

* Indicates that the tool can be used globally.



Color enhanced aerial image of New York City illustrating variations in vegetation cover. Image Credit: USFS

Table 1. Benefits and costs of trees currently quantified and in development in i-Tree

Ecosystem Effect	Attribute	Quantified	Valued
Atmosphere	Air Temperature	●	○
	Avoided emissions	●	●
	Building energy use	●	●
	Carbon sequestration	●	●
	Carbon storage	●	●
	Human comfort	○	●
	Pollen	○	
	Pollution removal	●	●
	Transpiration	●	
	Ultraviolet radiation	●	○
	Volatile organic compound emissions	●	
Community/Social	Aesthetics/property value	○	○
	Food/medicine	○	
	Health index	○	
	Forest products	○	○
	Underserved areas	●	
Terrestrial	Biodiversity	○	
	Invasive plants	●	
	Nutrient cycling	○	
	Wildlife habitat	●	
Water	Avoided runoff	●	●
	Flooding	○	○
	Rainfall interception	●	
	Stream temperature	●	
	Water quality	●	●

● = attribute currently quantified or valued in i-Tree
 ○ = attribute in development in i-Tree

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Image Credit: Thomas Kelley

Gotham Whale: Sighting and Tracking Sea Mammals Along Northeastern City Coastlines

By Paul Sieswerda

“The whales are coming to me...” or at least that is how it feels to me.

Since my retirement in 2009, I had been working with the American Princess, a tour boat out of Rockaway, Queens. I served as a naturalist on winter cruises to see the seals on Swinburne Island, a small haul-out about a mile east of Staten Island’s South Beach. This was a nice way to stay connected to marine mammals, an interest of mine throughout my career at both the New England and the New York Aquariums. Each year, the number of seals increased, and it was a fun activity without many demands. All that changed in 2010 when the captains of the American Princess began to get

reports of whales during the summer. “Whadayasay we try some whale cruises next year?” they asked. “OK,” says I, and with that, the course of Gotham Whale was charted.

2011 was a year of “adventure cruises” - “adventures” because we didn’t know if we would see a whale or not. Over the entire summer we had but three sightings, for a total of five whales seen - a sighting is from one place at one time and can include more than one whale. The American Princess is a commercial operation that, like a taxicab, needs paying customers to make a living and uncertain whale sightings do not make a profitable business plan. However, the customers were

happy enough because dolphin sightings filled in the gaps, and the rare sighting of a whale with the skyline of Manhattan in the background was special enough to give the captains hope. Being fishermen, they knew that next year might be better. And it was, more than double, and the year thereafter, more than double that. And so on. We knew whales were coming back to NYC!

In 2015, Gotham Whale was established as a 501(c)(3) not-for-profit eligible for grants and donations, with a mission to study, educate about, and advocate for the marine mammals in the waters around New York City, through citizen science. Citizen science is an old concept that is becoming a new

movement. In 1900, the Audubon Society began its Christmas Bird Count, an exercise asking its volunteers to count the number and species of birds that they see around Christmas every year in their own backyards. Hundreds, and now thousands of eyes take a census of birds from Maine to Mexico. These data develop a picture, a species. This is important work not possible without the participation of regular citizens.

The Christmas Bird Count model serves Gotham Whale in its mission for marine mammals around NYC. In my early years at the New England Aquarium, I witnessed an expansion of marine mammals into the area around Boston and Cape Cod. After being hunted to almost extinction, the 1970s introduced a number of protections for marine mammals that allowed populations to expand from their refuge in high latitudes to the more southern waters around Boston and Cape Cod. I see that happening today along Long Island and even around NYC. The abundance on Cape Cod is expanding to our waters, to an area of high human activity. The interface of humans and wildlife is fascinating to me and, I think, to others. The juxtaposition of breaching whales and skyscrapers is simply spectacular, while having whales

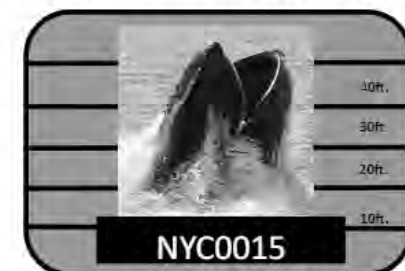
in the shipping lanes of the east coast’s busiest port brings environmental challenges on a similar scale.

So, Gotham Whale is immersed in the return of the whale. From being a part time gig to a more than full time job building the organization, my role is growing with the same order of

BE A CITIZEN SCIENTIST !!

MOST WANTED!

Public Interest No. 1



Whales of New York

DESCRIPTION: Whales are returning to the waters in and around NY Harbor. **Be On The Look Out for whales!!** Take pictures, note the Lat/Long or location, and send to: Paul@GothamWhale.org

REWARD = Free Beer



FINGERPRINTS: Like human fingerprints, humpbacks have unique patterns on their flukes. Gotham Whales’s NEW YORK CITY HUMPBACK WHALE CATALOG keeps a record of whales in our waters. (seals and dolphins too)

Citizens Scientists with “Eyes On the Water”, BOLO!!

Paul@GothamWhale.org Ph. 718-938-2067



Building a network of Sponsoring Bars and Breweries

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magnitude that we see in the number of sightings. Fortunately, everybody likes whales and I am fortunate to have an organization of helpers, all volunteers, doing the various tasks needed to operate. A core staff has been with Gotham Whale from the beginning and work to organize the other volunteers, educate at

table events, and advocate when necessary.

At the center of our work is the data. I call it our “currency.” It is the valued collection of datapoints from which we, as well as the other institutions that we share data with, can build pictures to better understand the return of the whales and the

implications for humans and the whales themselves. We mine this treasure from our partners aboard the American Princess, from other fishermen, from sailors with “eyes on the water” and from regular citizens who, in their travels, see marine mammals and take the time and effort to report the sighting in a standardized manner that can be used for science and conservation.

Sometimes, in today’s one-click world, that point is lost. Smart phones and built-in cameras with GIS positioning are a powerful tool for citizen science, which can be lost because of the ease of it all. The data

from a phone image contains ownership, position, date, and time authenticated within the file info on each photo. A marine biologist with multiple doctorates couldn’t produce more accurate information. However, what turns a citizen into a Citizen Scientist is a bit more effort than posting that picture to Instagram.

A structured process is needed for that datapoint to be used in peer-reviewed publications or as evidence for decision-makers. Gotham Whale provides that with our [on-line form](#) that ensures that the information is not “just grabbed off the internet” and has been vetted by our experts before being entered in the database. Called a Quality Assurance Program Plan (QAPP), this standard is being adapted for citizen science projects of all stripes, from water testing that is recognized by the EPA, to our own data that have been published in respected journals like *Marine Mammal Science* and *Marine Policy*. Without publication in such journals, regulators and legislators cannot consider it the “best available science” for decision-making.

Gotham Whale is bringing that message to the citizens of NYC

and with their participation, we want to build a hopeful picture of marine mammals as they return to the waters around New York City. It was a mission I couldn't deny as the whales, dolphins, and seals increase in my neighborhood every year. They are following me, I'm sure.

Paul Sieswerda is the Executive Director for Gotham Whale

Resources

Gotham Whale. <https://gothamwhale.org>.

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Image Credit: Issac Kohane



**WATCH THE FILM ON
GOTHAM WHALE!**





Photo of Alchemy painting by Jackson Pollock
Photo Credit: Luis Ribes Mateu, flickr

Fractal City: How Is a City Like a Jackson Pollock Painting? An interview with University of Oregon Physics Professor, Richard Taylor By Tim Beatley

Fractals are self-repeating patterns in nature and we have evolved to love and prefer them. A classic example is a tree: look from a distance and the tree has a trunk and major branches; zoom in more closely and smaller branches form smaller versions of the tree. Natural fractals are everywhere in nature: in meandering rivers, in mountains and topography, and in clouds.

Professor Richard Taylor, who heads the Physics Department at the University of Oregon, has spent much of his life studying fractals. He is convinced that they are one of the main reasons we respond so favorably to nature: it is because our bodies, and specifically our visual systems, have evolved to process fractals.

Taylor calls this “fractal fluency.” We have developed this visual system because we have evolved in a natural world full of fractals. Taylor’s research suggests that, because we have evolved over millennia looking at and viewing fractals, our modern eyes are better able to recognize and process these patterns.

Much of the credit for raising awareness about fractals and their power must be given to Benoit Mandelbrot, a Polish mathematician, who wrote the book *The Fractal Geometry of Nature* more than three decades ago. He coined the term fractal (from the latin fractis) an unfortunate, off-putting word choice, Taylor believes.

For Taylor, much of his fractal research started out as a way to analyze and understand what it is that we react to and prefer in art. Aesthetics and fractals go hand-in-hand, it turns out. Taylor famously analyzed the fractal composition and complexity of Jackson Pollock paintings, concluding that it is the paintings fractal composition that viewers favorably respond to. Taylor found himself working alongside those in the art world trying to monitor and detect forgeries, and in the case of a Pollock painting it is almost impossible to fake this unique fractal composition (something that Taylor’s computer models show). According to Taylor’s findings, Pollock’s drip method became more fractally complex

later in his career (during the late 1940’s and early 1950’s), as seen in paintings like *Alchemy* (painted in 1947).

The key insight behind fractal fluency, Taylor tells me, is “that your visual system is set up to process this complex imagery.” Taylor’s research analyzing the alpha and beta brainwaves recorded through EEGs found something unusual: both alpha and beta waves peaked when subjects were exposed to fractals. “It was both grabbing your attention and relaxing you at the same time.... It grabs your attention but it doesn’t wear your concentration down.” Fractals at once arouse and relax, captured in the way that we engage in “effortless looking” when it comes to such things as clouds. Our proficiency at recognizing patterns in nature helps explain why we sometimes see forms and shapes in clouds that do not exist (what Taylor refers to as

being fractally “trigger happy”!).

Planning for Fractal Fluency

We want and need fractal-rich cities and living environments. Taylor’s work points to a sweet spot of fractal complexity, or what he and his colleagues refer to as the “D” value, a measure of relative ratio of coarse and fine structure. The more complex the fractals are the better, but only up to a point. The mid-range D value is where our human (evolved) preferences lie and images or views (or paintings) with this level of complexity are especially pleasing to the eye.

The implications of fractal theory for design and planning are almost limitless. Nature-rich cities are by definition fractal-rich settings: we need and want more trees and nature. We have known that nature reduces anxiety and stress, makes us feel better, and happier, but Taylor’s

work suggests that much of that owes to their fractal composition. It provides a powerful theory for understanding why it is that we so enjoy and benefit from watching trees and clouds.

And it turns out that fractal fluency can find expression in other ways. We can also design our buildings and neighborhoods in ways that incorporate fractals and fractal geometry. Taylor and his team have just collaborated with designers at Mohawk carpet company to design a new fractal-based carpet line called Relaxing Floors. These fractal designs have already been winning awards and will soon go into production. As Taylor explains, “this is for commercial spaces like airports, hospitals, hotels;” places where stress-reducing qualities of fractals would be most needed. For Taylor, this is a logical extension of his work more than a decade ago for NASA, thinking about what kinds of interior



Appalachian Trees
Photo Credit: Clay Banks, Unsplash



Autumn Walk
Photo Credit: Andreas Dress, Unsplash

spaces astronauts would need to sustain them during long space missions.

One of Taylor's studies demonstrates that it is easier for humans to navigate through a fractal environment, suggesting ways to improve wayfinding in buildings or in public spaces. Fractal urban design and architecture has the potential to enhance not only the visual pleasure and enjoyment of cities but the practical ease of getting around. According to Taylor, "just as when you walk through a forest you're not designed to walk in straight lines, you're designed to take this fractal trajectory."

There are also other ways that fractals can provide bio-inspiration. For instance, fractal building design may help us better design structures that will withstand the forces of earthquakes. As in a tree, simple repetition of fractal shapes can deliver "immense flexibility" to a building's structure. There is evidence that shoreline protection structures that are fractalized are more effective, and that high fractal buildings and surfaces may do a better job dissipating wind, a result of their high surface area to volume ratios. Taylor also thinks these properties could maximize solar gain and solar production from photovoltaics.

We teach little in planning and architecture programs about the science of fractals and that is a shame. We could begin to evaluate the cities and landscapes we plan and design according to their fractal complexity. I asked Taylor about how we might go about doing this - he says: "you could take the very same computer programs that we have for the Pollocks and apply it to any object really." In this way, it would be possible to analyze a visual frame aimed at a downtown or a city's skyline, through which we might discover that (hopefully) our city resembled (fractally) a Jackson Pollock painting; a similarity that might surprise most residents.

Resources:

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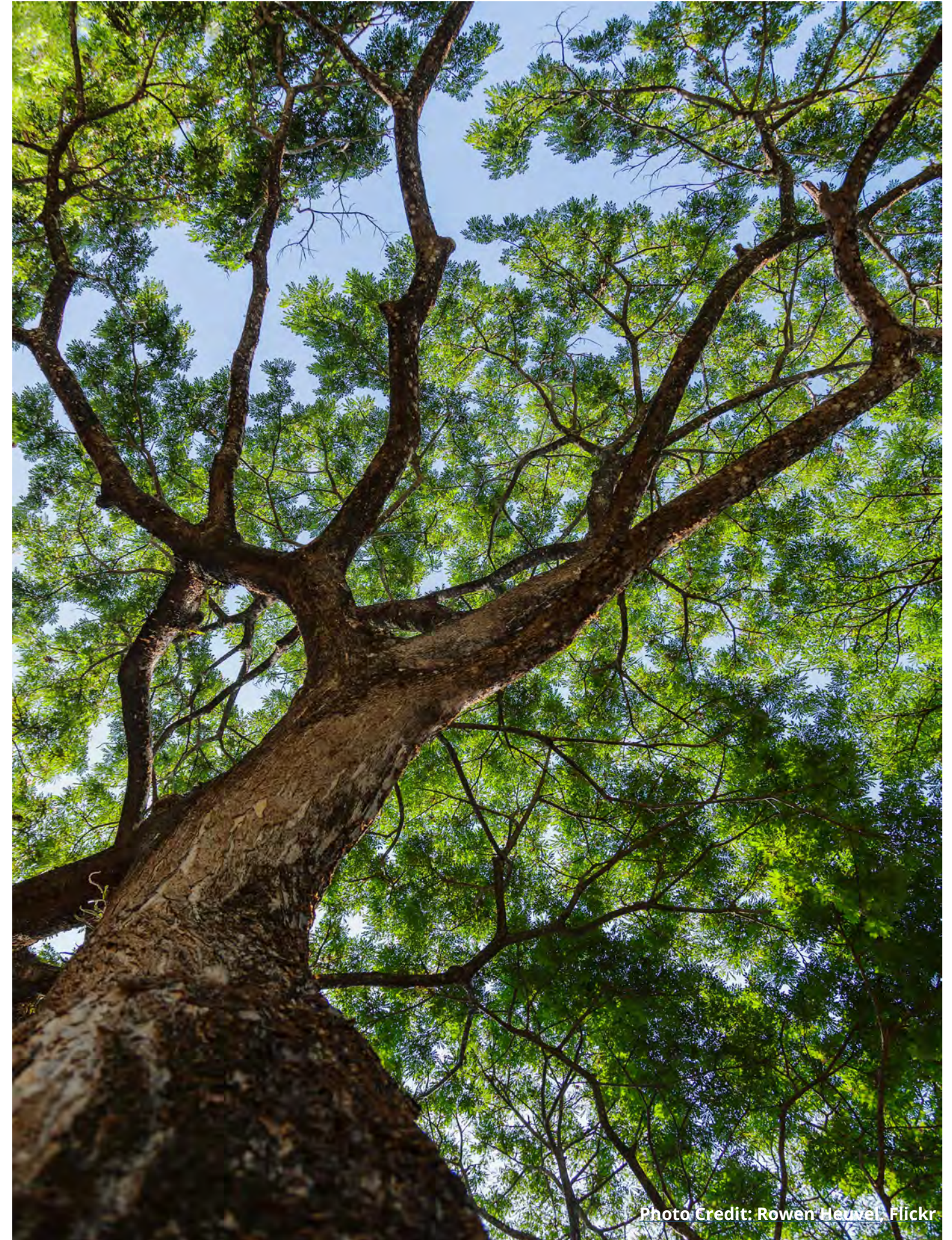


Photo Credit: Rowen Heuvel, Flickr



Tree-lined street in Philadelphia's Center City
Photo Credit: Sonja Dümpelmann

Multitasking Street Trees

By Sonja Dümpelmann

Since their systematic planting throughout the nineteenth and twentieth centuries, street trees have fulfilled various purposes in our cities. They have been considered variously as aesthetic make-up and creators of space; as territorial markers and instruments of defense, emancipation, and empowerment; as sanitizers and air conditioners; as upholders of moral values; as economic engines, scientific instruments; and as ecological habitat. Although street trees are successful multitaskers, which at most times have simultaneously fulfilled various purposes, different functions have been considered particularly important at different times.

Cool Trees

In the late nineteenth century, when cities were struggling to cope with uncontrolled urban growth and disease, street trees were a means for urban governments to bring nature into dense city centers, rendering the urban fabric more beautiful and civilized, and to cleanse and cool the air. As “ornamental trees” street trees could unify and connect a haphazard urban fabric. A particular species planted as a lead species in a neighborhood could also forge an identity and provide the area with a distinct character. As “shade trees” street trees quickly became important to improve public health. For example, in the 1870s, New York physician Stephen Smith

promoted street tree planting as a measure that could save up to 5,000 heat-related deaths in the city per year. In early twentieth-century New York City, social reformers and philanthropists realized that street tree planting was especially important in the rundown and overpopulated tenement districts. They formed the Tenement Shade Tree Committee that began to promote and facilitate tree planting along streets in these districts and at public schools.

Research into trees’ cooling functions and gas exchange, and the realization that they absorbed harmful carbon dioxide, also inspired street tree promoters in Berlin. There, street trees’ function in climate

mitigation and air filtration became especially pertinent after World War II when much of the city lay in ruins and rubble. The sharp edges of dust particles harmed eyes and respiratory organs. Street trees provided some relief by binding dust and providing shade from the glaring summer sun.

Threatened Trees

But Berlin’s reconstruction and the postwar economic boom led to the increase of vehicular traffic causing noise, and soil and air pollution threatening street trees once again. While they turned out to be noise buffers, street trees suffered from the de-icing salt that was washed into soils and from motor exhaust that polluted the air. New roads also led to the removal of trees, and some people even re-enlivened a nineteenth-century argument presumed dead: that trees did not belong in the city. Street trees, they posited, took up space that traffic and real estate needed badly. Street trees were obstacles in urban development and caused too many traffic accidents.

In mid-twentieth-century New York City, some business owners also looked at street trees with disdain. Although studies since then have shown that trees along business streets can promote urban commerce and increase sales, New York business owners were skeptical because trees obstructed sidewalk traffic, advertisements, and shop windows. Conflicts around street trees have arisen again and again, not least when they have obstructed street lights and blocked sunlight from

entering an apartment; when they have produced smelly flowers and fruit; shed seeds that clung to clothing; and when they have attracted unwanted insects and birds that speckle sidewalks with their droppings.

Ladies Trees

Yet, in the early twentieth century, female New York philanthropists, social reformers, activists, and early design professionals initiated street tree planting campaigns precisely to protect and attract birds to the city. The women also embraced street trees as a means and symbol of empowerment, emancipation, and even resistance. Initiating planting campaigns, they

transgressed the separation of private and public spheres and the binary of male-coded architecture and female-coded nature. Whereas the city and its marketplace were still largely determined and controlled by men, around the turn of the century, trees—considered an element of refinement and civility—both began to symbolize the female transgression of the domestic and public spheres and to be a means and material for this transgression. In Berlin, World War I propelled women to take over the task of tending street trees from men. After the war, in New York City, women initiated street tree plantings in the honor of fallen American service men.

In 1919 1,376 new Norway Maples were planted along streets in Brooklyn, by far outnumbering any other species planted. (Twenty-second Annual Report of the Department of Parks of the Borough of Brooklyn, City of New York, for the Year 1919 [New York: M.B. Brown Printing and Binding Company], p. 12.)



Empowering Trees

Decades later during the civil rights movement, African-American grassroots activists also began a street tree planting movement to improve inner-city life and reclaim their right to the city. African-American citizens transformed tree-planting and conservation activities into a means of empowerment and emancipation. “Plant-ins” became a tool of community-building as well as a civil right that could be used against ghettoization. One of the things distinguishing the tree planting activities from other civil rights initiatives was not only their grass-roots do-it-yourself and self-help character, but their aesthetic. Trees made a difference, in a visual and spatial

sense as well as in the more ephemeral atmospheric sense. Trees could fill the visual and phenomenological gap between top-down policies and the actual experience in the neighborhood.

Lumber Trees

At various moments in time, but in particular in moments of crisis, street trees also became a life-saving material resource turning the city into a forest or orchard that could be harvested. In New York City, the chestnut blight led to an unprecedented large-scale removal of trees from streets and parks in 1912, providing especially poor households with lumber. The coal shortage that hit the city in 1917 upon the United States’ entry into

the war again turned street and park trees into a welcome timber supply, as did Dutch elm disease that ravaged city trees beginning in 1933, and the damaging 1938 and 1944 September hurricanes. In Berlin, street trees provided citizens with firewood during wartime and in the postwar years. In fact, the Western Allies’ order to fell street trees for use as firewood during the Berlin Blockade 1948/49 incited one of the first ideological battles of the Cold War.

Fruit Trees

Besides lumber, in wartime Berlin street trees also provided vitamin-rich fruit and especially in the case of linden trees, flowers for infusions. More or less directly, street trees were used as weapons of defense and to achieve autarky. With biophilic and public health concerns in mind, recently, the City of Copenhagen decided it would plant trees and shrubs producing edible fruit and berries on public land and along streets closed to traffic. Across the U.S., for example, in Philadelphia, Seattle, and Evanston, IL, several urban food forests and orchards have been realized or are in the planning and planting stage. But these efforts have a history which goes further back than the twentieth-century World wars. While fruit tree planting along country roads has a long tradition in Europe and was promoted especially in the wake of enlightened ideals of land management and the building of a healthy body politic in the late eighteenth century, by the early twentieth century urban fruit trees standing on both private and public land were counted throughout the German Reich to

estimate necessary fruit imports and protect domestic production.

Truthful Trees

Regardless of the emphasis on specific purposes attributed to street trees at a particular time, trees are true multitaskers which have always responded and adapted to their environment, sometimes developing in unpredictable ways. As many indigenous peoples have believed all along and scientists and philosophers have now shown—among them Francis Hallé, Suzanne Simard, Stefano Mancuso, Matthew Hall and Michael Marder—trees, and plants more generally, can be described as sentient and intelligent living beings. This recognition in the age of climate change is contributing to the strengthening of the rights-of-nature movement which already gained uplift during the burgeoning environmental movement in the early 1970s when lawyer Christopher Stone published his influential essay on the question whether “trees should have standing.” Indeed, trees have been appreciated for their relative permanence and the durable physical spaces they create, and for the temporary, ephemeral, and more intangible mental spaces and effects they produce. In many climate zones and in multiple ways, they are therefore a relevant component of our cities.

Sonja Dümpelmann is a landscape historian and associate professor at the University of Pennsylvania Stuart Weitzman School of Design.



ORIENTAL PLANES
FOUR YEARS PLANTED

A regular row of Oriental plane trees in Brooklyn planted in the 1910s. (Twenty-third Annual Report of the Department of Parks of the Borough of Brooklyn, City of New York, for the Year 1920 [New York: M.B. Brown Printing and Binding Company], p. 53.)

A lumber camp in New York City. Removing dead and diseased chestnut trees in Forest Park, Queens. (Annual Report of the Department of Parks of the Boroughs of Manhattan and Richmond, City of New York, for the Year 1912 [New York: J. J. Little & Ives Co.], p. 354).



A LUMBER CAMP IN NEW YORK CITY.
Removing Blighted Chestnut Trees in Forest Park.

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Image Credits:
SF Parks Alliance

San Francisco's Street Parks: On the Power of Small Nature Spaces

By Tim Beatley

San Francisco has long been at the forefront of creatively capturing and repurposing small spaces. The city has become famous for its “parklets” of course, permitting the conversion of two or more on-street parking spaces into small public parks. This is an idea that has made its way to cities around the world. But this is only one of several such efforts the city has undertaken that involve multiple different city agencies.

There is also a living alleys initiative and an innovative sidewalk landscaping permit that allows residents to take up some of the pavement in their neighborhoods and replace it with biodiversity-enhancing flowers and greenery.

One equally innovative space-

repurposing program that we have admired over the years is the city's Street Parks program. Managed jointly by the City's Public Works department and the nonprofit San Francisco Parks Alliance, it takes small spaces owned by Public Works and makes them available as small parks and gathering places. Neighborhoods are required to step forward and propose a plan for a space, and one or more designated stewards must agree to tend and look after the space over time.

Many of the spaces are median strips in the middle of busy roads, and many are impossibly small or misconfigured in awkward ways. According to Julia Brashares of the San Francisco Public Works Department, who has been involved in running the program

for several years, the number of Streets Parks as of February 2020 is an impressive 210. By her count about 70% of these spaces (around 140 of them) are “active” in the sense that there are residents caring for and using them. There is a kind of “ebb and flow” to these spaces as some residents move away, and others discover the spaces anew. Overall, Brashares feels strongly these spaces and the program which helps to engage residents, create friendships and form social connections, as well as bringing nature and public space into these neighborhoods.

Over time, she tells me, “the sites are getting more complex and interesting.” There are now a number of tiled stairways in the program, for example, adding elements of color and beauty

to the neighborhood. There are often both natural and artistic elements to the spaces and they provide locales for a multitude of different uses and activities.

One of the newest street parks is called Ridge Lane. It consists of five narrow parcels the neighbors are working to connect via a public pathway. These are currently spaces that Brashares describes as “weedy and inaccessible.” Often what happens is that one neighborhood connects with another and is inspired by its work. That is happening in this case, as two nearby street parks groups are already working together to imagine how their respective spaces could be connected into a larger, longer “walking loop.”

The program is cultivating an engaged citizenry to help manage, care for and defend these community spaces, and to be involved in the larger politics of a city. Twice a year, Brashares tells me, the Parks Alliance puts on “Capacity Building Workshops” where groups network and learn more about each other as well as how the city works. “It does seem like there is more civic engagement,” Brashares tells me. “They get awareness about how the city works by participating in the program.” The process encourages neighbors who may not even know each other to begin to connect and build working relationships. “People get out of their houses, they talk to each other.” One group's work inspires another; there is a kind of important sharing and mentoring happening between the neighborhoods.



To help get residents started there is a Street Parks Manual, which lays out the process and steps needed to establish a Street Park, including sample site plans, a list of the responsibilities of street park stewards, and the street parks application and agreement.

It was good to hear the latest from Brashares about a street park I visited several years ago, La Playa, in the Sunset District, right on the city's Pacific edge. It was a very narrow median, but one that had been reconfigured to accommodate both native plants and a bocce ball field. It is going strong as an important community gathering space, she tells me, and there are now discussions with local merchants about how they can further improve and pedestrianize the larger area around it (the end of the street car lines, where the cars turn around).

I asked Brashares whether this very narrow but quite interesting

park was actually being used. Indeed, she tells me. Many residents visit the popular coffee place across the street and walk to the median street to sip and relax. “You see people reading, hanging out, talking, playing bocce ball,” she tells me, “It's very social, people are out there all the time.”

It's easy to underestimate the value of these kinds of small urban spaces, and the human connections and lasting power of the moments of community engagement and activism they represent. It is highly likely, as Julia Brashares confirms, that the program is a kind of training ground, a dipping of the toes (and perhaps a headlong plunge) into the world of city politics and local governance that will pay lasting dividends for the city.

Resources:

Groundplay. Parklets. <https://groundplaysf.org/parklets>.

San Francisco Dept. of Public Works. Sidewalk Landscaping Permit Application and Approval Process. <https://www.sfparkalliance.org/our-work/programs/street-parks>.

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sfbetterstreets. Living Alleys. <https://www.sfbetterstreets.org/find-project-types/reclaiming-roadway-space/living-alleys>.



Developing a Community of Opportunity: Sendero Verde

An Interview with Jonathan F.P. Rose, President, and Sabrina Barker, Senior Development Manager, at Jonathan Rose Companies

By Mary-Michael Robertson

Sendero Verde, a joint venture between Jonathan Rose Companies, L+M Development Partners, and Acacia Network (Architect: Handel Architects; Landscape Architect: AECOM), is currently under construction in New York City's East Harlem and will be a block of mixed-use development prioritizing biophilic design and affordable housing, scheduled for completion in 2021. With the central tenet of creating a "Community of Opportunity," it will be the largest fully affordable

Passive House development in the U.S. and will consist of 709 mixed-income residential units, 4,000 square feet of retail, 90,000 square feet of community facility space, and a 20,000-square foot central publicly accessible courtyard with 3 community gardens.

Biophilic Cities (BC): We'd love to hear more about the origins and planning process of Sendero Verde.

Jonathan Rose and Sabrina Barker (JR + SB): This site was in an area in which New York City's Housing Preservation and Development (HPD) and New York's Department of City Planning were already going through ULURP to rezone East Harlem for higher density along the major avenues. Sendero Verde was used as a model of the best of what could come from the larger rezoning. Since the project began as a response to

HPD's SustainNYC RFP, our basis of design started with its ambitious climate and energy efficiency goals. Included in the SustainNYC RFP were reports and workshops done by Community Board 11 and the GreenThumb gardens that occupied the site. The East Harlem Neighborhood Plan, which was a year-long effort by the community to gather neighborhood priorities and desires, was another source of inspiration. We aimed to meet as many of the goals laid out in these various plans as possible. Unfortunately, since this was a competitive RFP that was responded to by a variety of teams, the City process did not allow us to reach out to the community during the initial design and RFP phase. However, Jonathan Rose Companies, and our RFP teammate, L+M Development Partners, had both worked in East Harlem and had a good sense of the community's needs.

The project was deeply informed by Jonathan Rose Companies' interest in developing Communities of Opportunity, as a way to create pathways to wellbeing and out of poverty. Our goal was to create the best model of a newly constructed community of opportunity that we could. Both the City and the community responded positively to the idea in the RFP review process.

Once we won the RFP in February 2017 and started presenting the project at various community board meetings, we were able to hear directly from the community. From this, we increased the amount of permanent affordability we offered and lowered the highest AMI tiers as much as

possible while still making the project financially feasible.

BC: Can you tell us a bit about Sendero Verde's design?

Open space was incredibly important to us as well as the community, and the massing of the project and the meandering path reflects that goal. In 2016, the site was occupied by multiple GreenThumb community gardens that were required to be included in the overall plan of the new development. There was also a baseball field that was used by a local Little League team, so this block had a history of being an accessible open space within East Harlem.

The development of the courtyard grew out of our desire to preserve as much open space as possible. The program that we came up with during the RFP included a school, which needed a gymnasium. Given that it is very expensive to build a double height and column-free gymnasium below a residential tower, we decided to sink the gymnasium under a raised courtyard to reduce the cost of the clear-span space. Raising the courtyard also meant we could get a little more sunlight into the courtyard, but we needed to create a design that would draw pedestrians up from the street into the courtyard. This was done with the idea of the winding path from Madison Avenue and a grand staircase from Park Avenue. Early in our site investigations, we had discovered a map of an old Lenape Indian trail, and tried as best we could to duplicate its pathway through the site.

The massing of the buildings, including the shorter building to the South and the 34-story tower on the Northwest corner, was designed to provide the greatest amount of sunlight to the courtyard. We located the GreenThumb gardens on the southeast and southwest corners of the site, ensuring that they get as much sunlight as possible and will be accessible to the street.

Perhaps the biggest change to the project post-RFP was with the courtyard design. After winning the RFP, the Rose/L+M team was asked to bring a local community group into our partnership, and we added the Acacia Network to the team. One of the first things they asked us was to re-design the courtyard to reflect their understanding of community need. The courtyard is immeasurably better due to their input.

To activate the courtyard and to ensure year-round activity, the community facilities and the residential buildings all have direct access to the courtyard. Union Settlement, which is a youth and senior center, has a cafeteria that opens directly onto the courtyard. The school also has an entrance from their second floor and adjacent to their interior grand staircase to ensure connectivity to the outside. The pods of the courtyard were designed to appeal to a wide variety of age groups and community users. They were also carefully calibrated to respond to the interior uses. There is a stage and gardening pod adjacent to the school for outdoor learning and performances,

and adult exercise equipment located near the entrance to Union Settlement. We also have a couple more meditative pods for quiet conversation or contemplation, as well as pods for young children to play.

Early on, we had named the project Sendero Verde, or Green Path, in part a reference to previous projects of ours, Via Verde and Paseo Verde. The landscape architect came up with the idea of having a green ribbon of edging material line the project's pathway, from Park Avenue to Madison. This ended up informing our project logo. We required all of the landscape materials in the project to be "Manahatta" plants -- those that were indigenous to the region prior to 1491, and the project was designed to meet Fibonacci proportions. Both of these, indigenous plant materials and Fibonacci proportions, are elements of all Jonathan Rose Company designs.

Biophilic design carries throughout the entire design in subtle ways. In the community spaces, we've chosen wall coverings that evoke nature and are meant to create a sense of calm. The patterns, textures, and palettes of the interior spaces reflect natural tones and materials as much as possible. Wayfinding wallpaper and accent colors at the residential elevator lobbies and at the terminus of corridors pair with the ideas of biophilic design and carry throughout the project.

Amongst the requirements for this site, the RFP required that

the resulting project be built to Passive House Standards. The RFP gave HPD and the City the ability to test out the effectiveness of Passive House Standards on a project that they have some control over because it includes so much public financing. As part of the award process, we were required to share lessons learned with the New York State Energy Research & Development Authority (NYSERDA) and are implementing a building monitoring system to collect data on the various building systems so we can share the data with NYSERDA and HPD.

BC: How does research into the mental and physical benefits of access to green space and nature factor into this project?

JR + SB: All Jonathan Rose Companies projects take into account the mental and physical benefits of green space, healthy materials, proper acoustics, and energy efficiency.

At Sendero, providing direct access to the courtyard from every residential tower became a very important design requirement, even though it was relatively difficult to accomplish because it meant losing floor area from community facility tenants. Despite this economic pressure, we have maintained direct elevator access to the courtyard from all three residential buildings because we believe that being able to access great public open space is important for residents' health and wellness. The program of the courtyard is meant to appeal to a wide variety of age groups and

activity levels, ensuring a place for everyone to enjoy.

We also created open space on the roof of each residential building for more private outdoor activities. Each residential building has a rooftop community room that opens out onto a south-facing terrace. The terraces include solar trellises that offer some shade and places to relax, as well as outdoor planting beds for resident gardening.

BC: This project is innovative in a number of ways, including the fact that it will be the "largest fully affordable passive house building in the world when completed." Please explain a bit more about what "fully affordable" means in the development world and in the East Harlem neighborhood in particular?

JR + SB: The Federal definition of "affordable" historically has referred to households that make 60% or below of area median income (AMI), although that recently has been raised to 80% as long as the average is below 60%. Because the cost of living is so much higher in NYC, HPD defines affordable housing as any regulated housing at 165% of AMI or below. This housing is financed using financing term sheets from HPD/HDC and includes a regulatory agreement that stipulates affordability for a period of time. To assist in the financing of these units, HPD will give per-unit subsidy on units up to 130% of AMI (the amount of money per unit varies depending on the AMI level). The units from 130%-165% do not receive subsidy from HPD, but they do fall under HPD rental

regulations, and the renters need to be income qualified before they can move in.

At Sendero, we started the project by proposing units from 30% to 130% of AMI. Over time, we have adjusted those AMI levels to take into account new subsidy term sheets from HPD, as well as neighborhood concerns over gentrification. Since the original RFP award, HPD now requires any project receiving subsidy from the City to have a percentage of the building set aside for formerly homeless families. On Phase 1 of Sendero, that percentage was 10%. On Phase 2 we expect the percentage to be 15%. Another change since the RFP is the reduction in the 130% AMI units. As the term sheets have shifted over the last 4 years, the per unit subsidy on those units has dropped. We have also found that in a neighborhood like East Harlem, where a 130% affordable unit is similarly priced to a market rate unit, tenants don't want to go through the painful income verification process with HPD. As such, our current pro forma shows units from formerly homeless to 100% AMI.

We will follow the lottery process that is defined by HPD. All future residents will apply through the HPD Housing Connect website. We have seen projects get upwards of 100,000 applications. They will be placed into a lottery system and our marketing agent will run through that list to income verify each application, do credit checks, etc. It is an incredibly complicated process, but it ensures fairness.

BC: How does building a

passive house project impact affordability for the developer and end-user?

JR + SB: We have determined that doing Passive House added about 6-8% to the hard costs of Sendero Verde over typical affordable construction. The additional hard costs generally come from a more advanced mechanical system and the large Energy Recovery Ventilators (ERVs) on the roof that circulate fresh air throughout the building, additional insulation, rigorous air sealing, and triple-glazed windows. Since there aren't many certified passive house components in the United States, there are a limited number of manufacturers

from which we can purchase equipment. We believe that, as this standard becomes more universal, those costs will decrease.

We expect to see significant heating and cooling savings, but those have to be balanced against some increased operating and maintenance costs. There will be more filter changes to ensure that all of our mechanical, electrical, and plumbing (MEP) equipment is working correctly, and our staff will need to be able to make adjustments to various settings to ensure that the Passive House system is working correctly. We also plan to have a robust tenant information campaign



so that our building residents understand how to get the most out of the energy efficiency measures of the building. Our tenants should benefit from reduced air conditioning bills in the summer, as well as better thermal comfort during all seasons, better air quality, and quieter interior spaces.

One more benefit is passive resilience. If the power goes out, we believe that our apartments will be warmer in the winter and cooler in the summer than non-passive buildings.

Because the passive house design significantly reduces energy usage, the project's rooftop solar system is projected to provide 20% of the building's core and shell needs.

BC: To what extent does the concept of environmental justice inform your work and this project in particular?

JR + SB: Jonathan Rose Companies was founded to be a mission-focused company, with a focus on environmental and social justice. We first explored

indoor air quality for our 1996 project, Benedict Commons, in Aspen, and then Maitri Issan House, housing for formerly homeless people with HIV/AIDS in Yonkers, NY. Healthy indoor air quality has long been a focus of the Enterprise Green Community Guidelines, a program that we follow for every one of our projects.

All of our projects use environmentally friendly materials, including low-VOC paints and glues, renewable materials, recycled woods and products, and environmentally friendly

cleaning products. Passive House construction takes what we already do one step further, by providing fresh and filtered air directly to the units and ducted exhaust from the kitchen, bathrooms, service areas, and electric stoves, reducing the risk of carbon monoxide build-up when cooking.

We receive many reports from parents that once they move into our communities, their child's asthma goes away or is significantly reduced. This can improve school attendance and

performance.

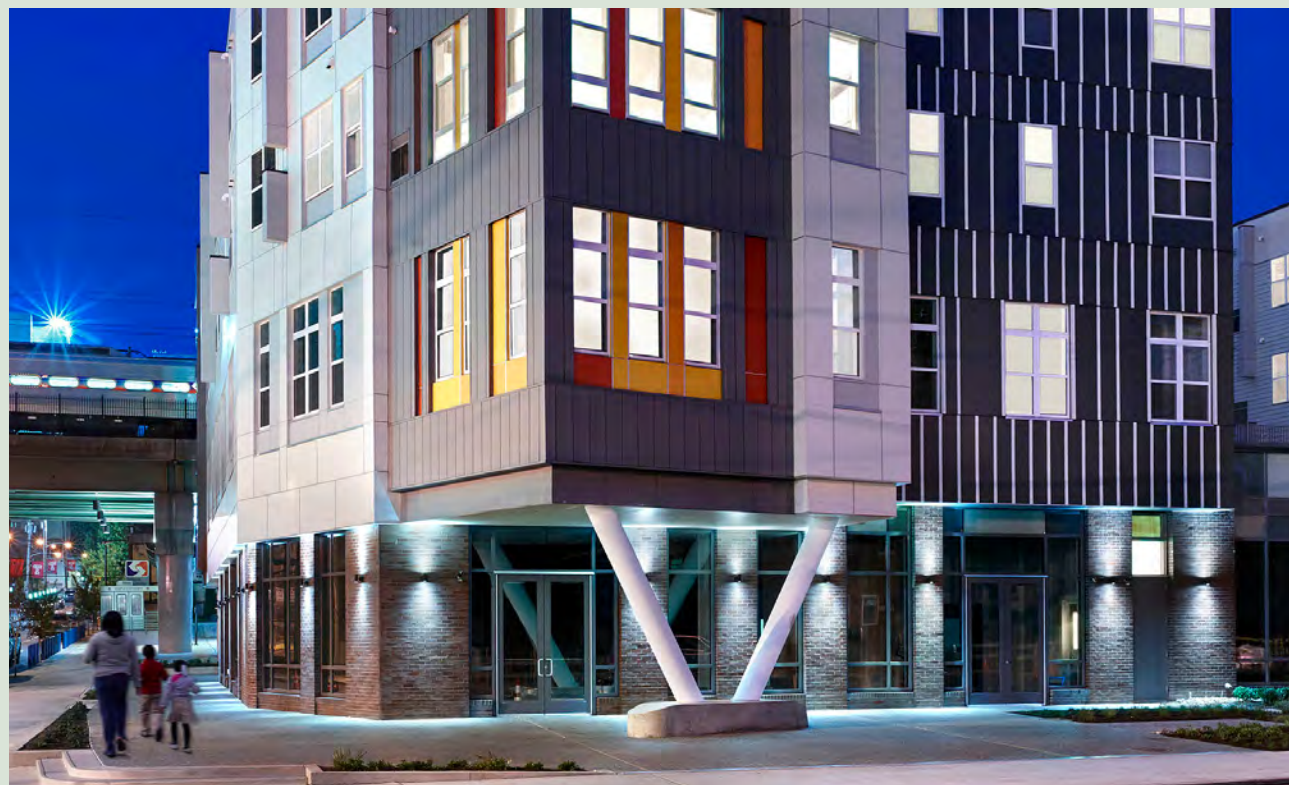
Providing safe, healthy and affordable housing is the foundation of our Community of Opportunity framework. When we provide homes that promote health and wellness, we foster an environment that improves our residents' quality of sleep, their ability to focus and study at home, their rates of asthma and sickness, as well as their overall sense of peace and well-being. When paired with access to other tenets of our Community of Opportunity framework, such

as access to public transportation, jobs, open space, and schools, we believe that these can help break the cycle of poverty.

Read more about Sendero Verde:
<http://www.rosecompanies.com/projects/sendero-verde>.

Paseo Verde (Completed 2013)

With the goal of creating a healthy living environment for low and moderate income families, this mixed-use rental housing project, developed in partnership with Asociación Puertorriqueños en Marcha (APM), provides access to both green space, in the form of landscaped terraces and green roofs, and to community services that include a primary care facility, pharmacy, and supportive services provided by APM. Winner of a dozen planning and design awards, the project is the first LEED for Neighborhood Development project in the country to achieve a Platinum rating.



Via Verde (Completed 2012)

Creating a new approach to green and healthy urban living in the South Bronx, the project provides affordable rental apartment and co-op housing. Its stepped form is inspired by the integration of nature and city. Connected green rooftops harvest rainwater, grow fruits and vegetables, and provide open space for residents. Other amenities that contribute to healthy living include open air courtyards, a health education and wellness center, health oriented retail space, a fitness center, and bicycle storage.





Flying Gardeners, Boscoe Verticale
Image Credit: Laura Cionci

Emergence of the Forest Aesthetic and the Idea of Living within Ecosystem Curves

By Jana VanderGoot

There are designed projects in the built environment where urbanism is “forest.” These artworks, buildings, landscapes, and development strategies have in common the idea of an underlying matrix, or a surrounding substance and foundation, made of a continuing and resilient ecosystem of trees, understory vegetation, wildlife, soils and microorganisms, terrestrial and atmospheric elements, and water cycling. The designers of these projects treat forest as both a base condition and a protective overlay for commercial, residential, industrial, and civic programs in even the most densely populated urban areas. In these projects forest is an architectural vernacular, or a material and design language

that has been tested, studied, and known for as long as humans have existed. The phenomenon of the “forest aesthetic,” as defined in the book *Architecture and the Forest Aesthetic: A New Look at Design and Resilient Urbanism* (VanderGoot 2018), is used to describe these projects of the forest.

As a theoretical position, the forest aesthetic responds to a handful of well-known forest projects, which emerged in architecture, landscape architecture, and urban studies in the late 1990s and into the first decades of the 21st century. The forest aesthetic book aligned the current projects with historical case studies to create cross-disciplinary inroads for more

complicated, yet urgently needed conversations about greenhouse gases in the atmosphere, toxicity of the materials that humans use to create the built environment, and the well-being of humans and other organisms on Earth.

In the discipline of architecture specifically, contemporary projects of the forest have too often been discussed as one-liners. However, when paired with new developments in landscape architecture, urbanism, and forest science, it becomes clear that the potential impact of these important conversation-starting projects is broad. For example, the Bosco Verticale (vertical forest) project in Milan, Italy by Stefano Boeri Architetti (2014) is often simply called a “forest

skyscraper.” However, pairing Bosco Verticale with earlier built work by Friedensreich Hundertwasser in Austria and Milan, Italy in the 1980s reveals a lineage of thinking about the forest in connection to buildings in the City of Milan. Digging deeper into the design of the Bosco Verticale towers also makes it clear that the towers are only a small piece of a much larger design vision called Biomilano, where the City of Milan becomes a human-forest biome. In a human-forest biome, the forest is an architectural building block used to create human habitat and also a highly effective, long-term infrastructural strategy for balancing carbon cycles and maintaining air quality in urban areas. In the Biomilano plan, metrobosco (city forests) are planted with fast growing tree species in order to remove carbon and other pollutants from the atmosphere. Metrobosco are then harvested and contained in

casa bosco (wood social housing) made possible with mass timber building technologies. The industry created by this cycling of forest urbanism is the background for living in the human-forest biome. What distinguishes this human-forest biome is that peaks in the curve of carbon dioxide and other greenhouse gases released into the atmosphere can be flattened through development and urbanism.

Another example of a built project where the temperate forest is an architectural vernacular is the Murray Grove nine-story all-timber residential high-rise designed by Waugh Thistleton Architects in London, United Kingdom (2008). In the field of architecture, Murray Grove is recognized as a prototype for the Tall Wood Building. This category defines buildings taller than 26 m (85 ft)

and built with large panelized wood, also known as mass timber construction. Cross-Laminated Timber (CLT) panels were used for floors, stairs, and external party and core walls on all eight floors above the first floor at ground level at Murray Grove.

Murray Grove helped to change building codes for medium to high-density housing. One of the first projects referred to as a “plyscraper,” Murray Grove was a break-through with regard to building code standards for fire safety that had required structural systems of high-rise buildings to be made of concrete and steel. The Murray Grove team worked to establish new codes in the United Kingdom. Soon after, the mass timber trend quickly became global. In 2015, the International Code Council (ICC), whose voting members are building and fire officials from all over the United States, adopted



Murray Grove
Image by Will Pryce (Waugh Thistleton Architects)

ANSI CLT Standard PRG 320 to allow the construction of mass timber high-rise buildings in the International Building Code (IBC).

As Bosco Verticale is much more than a forest skyscraper, Murray Grove is also much more than its skyscraper name. Murray Grove is a project that makes an economically viable argument for lengthening the period of time in the carbon cycle when carbon is contained in Earth's crust (the biosphere, hydrosphere, lithosphere, and pedosphere). Over a decade ago, Waugh Thistleton was making what are now common ideas about carbon containment accessible to the public by describing it in their book, *A Process Revealed*. The authors note that: "Substituting concrete for timber reduced the carbon offload of Stadhaus [Murray Grove] by 300,000 kg (661,387 lbs). This is equivalent

to the entire carbon use of the building over twenty years of occupation." (Thompson et al. 2009). Waugh Thistleton's economic argument did not factor in the additional savings to be made through carbon credits for carbon contained in the wood of the building. As society moves to meet benchmarks in newly proposed legislation like the Green New Deal in the United States and the America's Pledge response to the United States' withdrawal from United Nations Paris Agreement in 2017, certified carbon credits will likely only increase in value.

In addition to mass timber, other building products are emerging from the same forest systems to help flatten the curve of greenhouse gases and toxic VOCs released into the atmosphere. Formaldehyde-based adhesives are being replaced by CNC-

routed wooden dowel and dovetail connections. Petroleum and chemical-based sealants are being replaced with shorter lived yet less toxic tree pitch resins, waxes, gums, oils, and fibers from the forest. Laser scans of solid timber now detect knot holes and flaws in order to help ensure that wood panels are airtight. This reduces some of the need for plastic vapor barriers and metal foils. (Lennartz and Jacob-Freitag 2016). Landscape-based carbon-positive technologies that can be deployed at a large scale are also being developed for decommissioned wood biomass from cleared forests that are thinned to prevent wildfires and from the demolition of mass timber buildings as they reach the end of their useful lifecycles.

These design projects of the forest all anticipate the day when people will demand the ability to

"buy local" and "organic" as they purchase homes, rent office space, or fund a development project. That market demand will signal a shift to living resiliently within the curves of urban ecosystem habitats.

Jana VanderGoot is an Associate Professor of Architecture at the University of Maryland, a licensed architect, and a founding partner at VanderGoot Ezban Studio.

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Cross-Laminated Timber with pre-cut openings
Image Credit: KLH



Image Credit: DMCA

The Footprint of a Piedmont Forest: Interface Base Camp

By JD Brown

With its ambitious adaptive reuse of a 1950s-era office building, Interface has aspired to design a company headquarters whose footprint is no greater than the Piedmont forest that once stood upon the same ground before the rise of modern-day Midtown Atlanta. Such a lofty goal reflects the company's decades of leadership in first sustainability and now biophilic design. In a moment of particular inspiration, the envelope of the Base Camp has been wrapped in a covering image of the Piedmont forest it seeks to emulate.

For more, watch the [short film about the Base Camp](#) from Biophilic Cities.



Interior and Exterior Images of Interface Base Camp
Image Credits: JD Brown



Kingsland Wildflowers Green Roof Top
Image Credit: Rica Robles

Doug Tallamy's Urgent Call for Native Plants and Trees

By Tim Beatley

One of the benefits of a newfound love of the app iNaturalist is that I am able to quickly identify the species and provenance of the plants and flowers I see around me during the course of a day. It is at once delightful (to be able to precisely identify a species) and exceedingly depressing, as it seems most of the visually remarkable flowers I see in late spring in Virginia are non-natives, and many are clearly invasive. My running list of plants includes many ubiquitous non-natives including: red deadnettle; common vetch; periwinkles; lesser celandine; and garlic mustard, which I will say seems to be everywhere right now. Before embracing this wonderful new digital identification tool, I simply had not appreciated the extent to which non-natives had taken over.

University of Delaware professor of entomology and wildlife ecology, Doug Tallamy would not at all be surprised. He has become the high priest of native plants, a persuasive voice on behalf of planting native trees and plants, built on an impressive body of scientific studies and evidence of which we should all take note. I spoke recently to Tallamy, both of us hunkered down in the new pandemic world. Tallamy normally has a busy lecture schedule, but in early March that began to disappear. The timing is not great—Tallamy has a wonderful new book, [Nature's Best Hope](#) (Timber Press, 2019).

Tallamy's main message is a critical one: just about everything many of us care about, for instance my love of birds, depends on a foundation

of native trees and plants. As I write this, several billion birds are migrating to their summer nesting grounds and beginning the process of laying eggs and raising young. For most of these birds nesting success will depend on finding (and stuffing into the hungry mouths of chicks) a startling amount of food. For most species this means caterpillars and many of them. Raising one nest of black-capped chickadees will require an astounding 6,000-9,000 caterpillars! Because of the co-evolution of plants and insects, an exotic ginkgo tree, Tallamy tells me, "is not going to sustain the birds in my yard."

We need more native plants and trees, but we especially need to make sure we plant what Tallamy calls "keystone" plants. These are the super-productive natives

that serve as hosts for a diverse array of invertebrates. "We want to make sure that the keystone plants are the backbone of our landscapes." Some 5-7% of native plants, Tallamy says, provide more than 75% of the food in the food web that sustains birds and other animals. Tallamy and I share a love of White Oaks. In addition to their majesty and beauty, I now have another reason to admire them: they are at the apex of the list of keystone plants and trees, serving as host for a remarkable 557 species of caterpillars.

There are other things we can do. Multiple layers of vegetation in our yards are best. For example, because many insects pupate on the ground it is important to allow wild growth to occur around the base of trees. Eliminating or reducing the use of pesticides and herbicides would also help. An even bolder idea is to begin to see each individual yard as part of a larger ecosystem, with connecting

yards and lawns serving as biological corridors. To this end, Tallamy challenges homeowners to convert at least half of their turfgrass yards to native plants and trees. If everyone followed that advice that would result in some 20 million acres of new habitat. Collectively, this contribute to the newest and largest national park in the U.S., what Tallamy refers to it as a Homegrown National Park.

It is an inspiring vision but one that faces some obstacles including an entrenched American notion of the value of the suburban lawn. When it comes to the monocultural approach to manicured lawns, cultural sway and neighborhood peer pressure often make it a matter of taking the easy way for many homeowners and just fitting in. Local ordinances and HOA covenants often go so far as to outlaw the kinds of lawns that Tallamy has in mind. But, even more of an obstacle may be our

lack of imagination and our staid and static aesthetic about what a yard should look like.

It is worth noting that there has been no lack of writing and advocacy about this in the past, including Yale Professor Herbert Bormann's *Re-Designing the American Lawn* (along with Diana Balmori and Gordon Geballe), which is now close to three decades old. I have been using that book in my classes for a long time and it is a reminder about how long it takes to instigate meaningful change. It has been a perennial challenge and subject of discussion for as long as I have been teaching. What Tallamy and his colleagues add is the pretty compelling body of evidence and research about the ecological value of natives, and native-planted yards, and a sense of renewed urgency about what needs to be done.

I asked Tallamy about cities and whether his advice about

planting natives made equal sense there. “I don’t accept under any circumstances the notion that native plants don’t do well in cities, that it has to be a plant from China. There’s absolutely no logic to that at all.” He described, as an urban legend, the belief that we need to select and plant heartier non-natives in cities.

Tallamy’s work does not specifically focus on natives in urban settings but the implications for what we might choose to plant in cities (but often don’t) are clear. He tells the story in Nature’s Best Hope of a visit to Portland and an impromptu exercise in counting the number of street trees native to the Northwest. To his surprise, he finds the vast majority of the trees he counts are not in fact native at all. Even in an iconic green city like Portland, he finds, deference to nonnative trees seems the rule.

Considerable progress has nevertheless been made in many

cities. Our Australian partner city Fremantle, for example, runs a program to subsidize and assist in the [planting of natives along roadway verges](#). Phoenix, another partner city, has witnessed a significant shift from turfgrass yards to desert natives and xeriscaping, much of it motivated by the need to conserve water. Tallamy estimates that we use 8 billion gallons of water per day irrigating our turfgrass lawns. Phoenix recently [converted the landscaping at its Sky Harbor airport from high-water turfgrass to low-water natives](#), saving energy and public funds as well as water.

There are reasons to be hopeful as we see the establishment of native plants in many parts of cities--for instance on rooftops or building facades and the landscaping around and between public buildings. Cities like New York and San Francisco now have rooftop mandates (requiring the installation of either

photovoltaics or green roofs) and much of the planting can take the form of natives. A wonderful New York City example is [Kingsland Wildflowers](#), a former warehouse in Brooklyn, with a rooftop converted to a 10,000 square foot “wildflower meadow”. By one estimate, there are some 40,000 acres of rooftop space in New York City alone that could serve as habitat for bees, butterflies and birds.

Even in cities where residents are able to change our planting choices, effective control of non-native invasives remains a serious challenge. The amount of labor required is large and the task never-ending. Alternatives, such as the use of herbicides, are not very attractive. There are some 3,300 invasives found in the U.S., so the challenge is great indeed. My iNaturalist observations have given me a sense of how Herculean the task would be.

Urban lighting is another serious problem, Tallamy stresses. We

can plant natives everywhere, “but when you surround them with lights ... they don’t work anymore.” By reducing our outside lighting, we can reduce the insect loss. Shifting to yellow-hued LEDs, when and where lighting is needed, would also help. “Immediately you’ve stopped the slaughter of insects at your lights all summer long.”

I must admit that I am at a loss to understand why we need to plant non-natives, when we have so many natives that are beautiful and magical. Two yellowwood trees in our front yard are for me exhibit number one. In bloom now as I write this article, they are a quite resilient native that puts on a show of fragrant white flowers every spring and is a hardy species that will do well in our increasingly hotter cities. I have recently taken on the mission of planting some native flowers in my yard and several are truly spectacular, including Marsh Marigold and Green-and-Gold. There is something reassuring in knowing they belong and that they are in their small way helping to undergird a larger food web.

But there are hiccups to overcome. Our small local native plants nursery, where I sourced my native plants, has stopped taking orders and isn’t even answering my emails. This is a good sign on one level as demand for natives picks up. But, I am sure there is no shortage of conventional (and non-native) alternative plants available in the bigbox and chain garden shops. We buy what we know and what is easy to find I am afraid. Cities like Fremantle that emphasize natives are bolstered



Black-Capped Chickadee
Image Credit: Tom Murray

by well-established and long-standing native plant nurseries (such as the [Apace Revegetation Nursery](#) in Fremantle); indeed it is quite common for Australian local councils to operate their own nurseries.

The cover of Tallamy’s book (an American Robin clutching a caterpillar) suggests that the way to our hearts may be through our love of birds. Birds are a definite “hook” he tells me. The birds that have kept me company in recent weeks, the goldfinches, house finches, blue birds, and nuthatches, are truly like members of the family during this age of coronavirus. Tallamy notes in his book the important emotional connections that we develop towards birds: “The cardinal in your yard is not just a cardinal in your yard,” he says “it is your cardinal.” And, in this way, we care deeply about their health and wellbeing, their ability to secure adequate food and water, and their ability to find sufficient caterpillars to raise their young! I believe Tallamy is right, but I must also say I

care similarly and deeply about the goldenrods and the marsh marigolds, and especially the two yellowwoods living in the front space of our home.

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A Splash of Yellow-Marsh Marigolds
Image Credit: Ian Preston



Image Credit: Ian Leahy

Exploring a Biophilic Frontier Within

By Ian Leahy

“A passionate love of life and all that is alive.” This is the lofty, transcendent way German psychologist Erich Fromm defined biophilia. Yet, so often, our biophilic entry point in cities is infrastructural. Not surprisingly, those of us who advocate for green infrastructure immediately find ourselves in a literal turf battle against better funded interests. We suppress this potentially transformational bond, leaning instead into quantitative calculations and financial returns on investment to justify nature’s existence where we dwell.

It’s not that such data isn’t critically important, but the biophilia hypothesis posited by biologist E.O. Wilson is that humans possess an innate tendency to seek connections

with nature and other life forms. Are we missing a deeper entry point?

Perhaps part of the problem is the word itself: love. While the Greeks defined *philia* as the friendship form of love, not erotic or divine, when we say saccharine things like “love all that is alive” we don’t have any context through which to experience or translate that into more than superficial appreciation.

Yet, anyone who has experienced transcendent love, even among friends, knows that it doesn’t define the ego, but rather dissolves it into something greater than itself. How, then, do we actually connect with “all that is alive” on a level that unleashes the full potential of biophilia, and how might that transform the

places we live?

On the Edge of a City Park

At the age of 18, watching the collapse of post-industrial Detroit on one side and sprawling development consume rural forests and farms on the other, I asked a question that would haunt me forevermore: What are we missing that keeps us from building a civilization that actually works?

Committing to an experiment where I would follow instinct regardless of outcome, I kept being drawn back to trees, as if they held an answer I could not yet access. It eventually became clear that what we’re missing couldn’t be found in the realms of politics or economics, but rather in how our psyches

fundamentally relate to the world. The pieces finally came together on the edge of a forested city park.

I instinctively responded to seemingly random occurrences in nature – a spider crawling, a bird flying overhead, a leaf flickering among thousands. Before my rational mind could negate the sense, I moved toward each in succession. The first time, I was guided to the largest tree in the park. It felt like the seemingly disparate aspects of nature were communicating with me as one coherent entity. For that brief period, the boundaries of my ego dissolved into nature. On my second attempt, an image flashed in my mind of a compost pile that I had never before seen. Sure enough, I was guided, instinctual signal by instinctual signal, to that very compost pile in the far corner of this forested park.

Peculiar as this may sound, such transcendent experience

driven by instinct is not a new concept. In fact, it was a defining philosophy of early America.

Salvaging the American Experiment

In his 1841 *Self Reliance* essay, transcendentalist Ralph Waldo Emerson helped lay the foundation for a uniquely American conservation movement that would later be institutionalized by the creation of my organization, American Forests, in 1875. Rather than initially focus on policy, coalitions and infrastructure, Emerson implored people to first go within. He said we should move beyond dualism and trust our inner connection to the “unity in nature and consciousness.” To get there, he found it critical to “trust instinct to the end, even though you can give no reason.”

Likewise, philosopher Jacob Needleman, in his book *The American Soul*, described how

the founders of the United States envisioned that, once material needs were met, we would turn inward to explore that endless frontier. Suffice to say, we have yet to get in the right lane for that exit ramp.

Once the hope of the world, the American experiment of limited institutional control and maximum individual responsibility has become mired in consumption, overreach and an addiction to growth for the sake of growth. Our notion of self-interest often extends no further than our immediate families. Our quest for individual liberty, reflected in our sprawling built landscapes, has created many back patios and fewer front porches as we have drawn boundaries around individuals rather than relationships.

And yet, there is still a pulse in the borderland psyche of this liminal nation that yearns for something transcendent. We



Parc Du Mont Royal in Montréal
Photo Credit: JP Valery on Unsplash

readily gutted old institutions, governments, and systems to build aspirational new ones that distributed power to the many.

We are drawn to the mysteries of religion at far higher rates than other developed nations. Our entertainment is moving from detached, ironic postmodernism (think Seinfeld) into a metamodern era where disparate characters seek integration, unity and purpose with one another (think TV shows like Parks and Recreation or Community). After generations sought physical and psychological separation on the landscape, we have seen an unprecedented shift in development patterns, with around 80 percent of new construction nationwide being mixed-use in recent years. This voluntary shift suggests a cursory

yearning for deeper connection with other life. Even our free market ideal, increasingly out of fashion among the young who are largely driving this integration, holds an unrealized potential at such a unitive level.

The Economics Within

Both ecology and economy function on the same underlying principles. Trees in a forest compete for limited resources in the nutrient market the same way businesses compete for customers. A tree that gains an advantage in sunlight, water or nutrients can eventually force its competitors into submission. Meanwhile, an understory of shade-dependent species can emerge in that dominant tree's shadow just as the presence of a large industry in a community

supports suppliers, restaurants and other secondary industries.

But, what if, like quantum physics in relation to Newtonian physics, there is another set of less visible but equally valid laws operating in both systems? If seemingly independent components of an ecosystem actually do function as a cohesive, self-aware whole, then it stands to reason the same laws would exist in economics. And if individuals can access this set of ecological laws through sub-rational instinct, then we should be able to do the same for engaging the economy at a level that rises above any need for cutthroat competition.

Much like being guided to a specific destination in a forest by responding to seemingly random cues in nature, one

could learn how to instinctively respond to small cues in their everyday economic life that might eventually lead to a defining project, the right job opportunity or a career path the more superficial desires of ego never considered.

I don't mean to suggest this would be some guaranteed path to riches and glory. It is important to keep in mind that evolution advances through disruption and chaos. From violently shifting bedrock to galaxies crashing into each other, there is no evidence that our universe exists to be stable. As writer Leonard Cohen mused on the arrogant notion of taming life's chaos, the ideal psychological state is to ride "the drifts like an escaped ski." As such, we might eventually come to view the economy not as the purpose of our existence but rather as a tool capable of providing the necessary resources, or lack thereof, for each stage of our respective journeys into full potential.

The Urban Forest Gateway

While this may all sound utopian, the urban forest grounds it, providing a gateway into this integrated psychological space. For example, an enhanced version of forest bathing could be structured to teach individuals how to instinctually follow cues from nature in their own neighborhood parks. They would then be well positioned to learn how to apply that transcendent experience with nature to their own economic lives.

At scale, we might find that this once radical American



Image Credit: Ian Leahy

experiment in self-governance, forged in the only nation to be founded on a philosophy, still has something to offer the global era. As the perception of separation between organisms fades, so too would the need for heavy regulation and forced redistribution. Each individual's economic behavior would voluntarily account for both their own and the collective interests simultaneously. A more integral economy would slowly emerge because we would experience the suffering of one as the suffering of all. Our desire to live immersed in transcendent connection to nature, both indoor and out, would become palpable. Every aspect of our cities, from offices to retail, transportation

and parks, might then come to reflect a passionate love of life and all that is alive. In other words, our cities could finally become truly biophilic.

Ian Leahy is the vice president of urban forestry at American Forests. He writes from Washington, D.C.



Image Credit: Benjamin Elliott on Unsplash



River, Trees and City
Image Credit: Cristian M. Loan

Urban Forests: Nature as a Resource

By Jess Stevens

The following is an opening excerpt from a longer legal white paper (available here), which provides an overview global urban forest policy and extensive links to further resources.

Cities around the world are feeling the pressures of climate change and high population density. Urban forests are increasingly recognized as “green infrastructure,” highlighting the quantifiable public goods they produce to combat the many problems arising from urban development and climate change.

Despite their countless benefits, urban forests face a barrage of threats including development, drought, vandalism, and lack of adequate maintenance. Tree canopy in U.S. cities has been

declining rapidly over the past fifty years due to development and mismanagement. Cities must begin developing strategic plans for the long-term preservation and growth of their urban forests.

Cities at the forefront of solving this crisis have developed comprehensive urban forest plans to supplant antiquated urban tree maintenance ordinances and have set strategic goals for increasing tree canopy in their urban areas.

What follows is an examination of the benefits of urban forests followed by a guide to creating an urban forest development plan and case studies of cities that have instituted comprehensive urban forest plans.

Environmental Benefits

The term “Heat Island” describes the fact that urban areas experience higher temperatures than surrounding non-urbanized areas. Increasing global temperatures and the risk of heat wave events in urban areas represents a serious public health concern.

Heat islands disproportionately impact communities with limited adaptive capacities including those considered low income, high poverty, low education, elderly, and ethnic.

Tree planting is one of the most effective means of mitigating urban heat islands. Trees lower air and surface temperatures with shade and evapotranspiration.

Mature tree canopy reduces air temperatures by about 5 to 10 degrees.

In addition to lowering air temperatures and reducing energy use, trees also reduce the amount of carbon dioxide in the atmosphere by fixing carbon during photosynthesis and storing carbon as biomass. In 2005, urban trees alone stored 643 million tons of carbon.

Urban forests help create and enhance animal and plant habitats and can act as “arcs” for endangered species.

Trees clean air by absorbing carbon dioxide, Sulphur dioxide, nitrous oxides and other pollutants. They also shade trees which reduces ozone emissions from vehicles. It is estimated that urban trees in the U.S.

remove 711 thousand tons of air pollution annually. A service valued at \$3.8 billion.

Urban forests can reduce annual stormwater runoff by as much as 7 percent and mature trees can store 50 to 100 gallons of water during large storms. Green streets and tree planting are 3 to 6 times more effective in managing stormwater and floodwater than conventional methods.

Urban trees and other plants help remediate contaminated soils by absorbing, transforming and containing a number of contaminants. Trees also divert captured rainwater in the soil, where bacteria and other microorganisms filter out impurities. This reduces urban runoff and the amount of sediment, pollutants, and organic matter that reach streams.

Social Benefits

The cognitive and behavioral effects of exposure to nature are far-reaching. Access to nature increases attentional capacity, positive emotion and problem-solving skills. It also aids in recovery from mental fatigue.

Urban forests also impact physical health. In urban settings, the percentage of green space near a person’s home is significantly related to perceived general health. People exposed to greener environments also experienced lower levels of income-deprivation related health inequalities from all causes.

Urban areas characterized by high vegetation report fewer property and violent crimes than areas that lack vegetation.



Forest Walk, Southern Ridges (Singapore)
Image Credit: Kars Alfrink on flickr

This may be because urban green spaces contain 90 percent more people than barren areas on average. It could also be because green space creates more opportunities for social connection, cohesion and community building which leads to more vigilant supervision of neighborhoods.

Economic Benefits

Urban forestry creates jobs. In California, urban forestry supports over 60 thousand jobs and contributed more than \$3.5 billion in value to the economy in 2009.

The presence of street trees increases residential property values. In several cities, street trees increased the collective value of homes by more than

\$1 billion. Commercial offices in green urban areas also rented for 7 percent higher. Shoppers are willing to travel further to visit urban areas with high vegetation and spend more time shopping when they arrive. Shoppers in forested urban areas also spend between 9 and 12 percent more for products than they otherwise would.

Tree shade lowers temperatures and may reduce energy consumption and spending. Properly placed trees can reduce cooling costs by 30 percent or more.

Urban forests could lower the economic costs associated with traffic accidents. Studies have shown that drivers drove slower, had less road rage and had fewer accidents when roadways were

naturally landscaped. Tree shade also reduces pavement fatigue, cracking, and other distress which saves on repair costs.

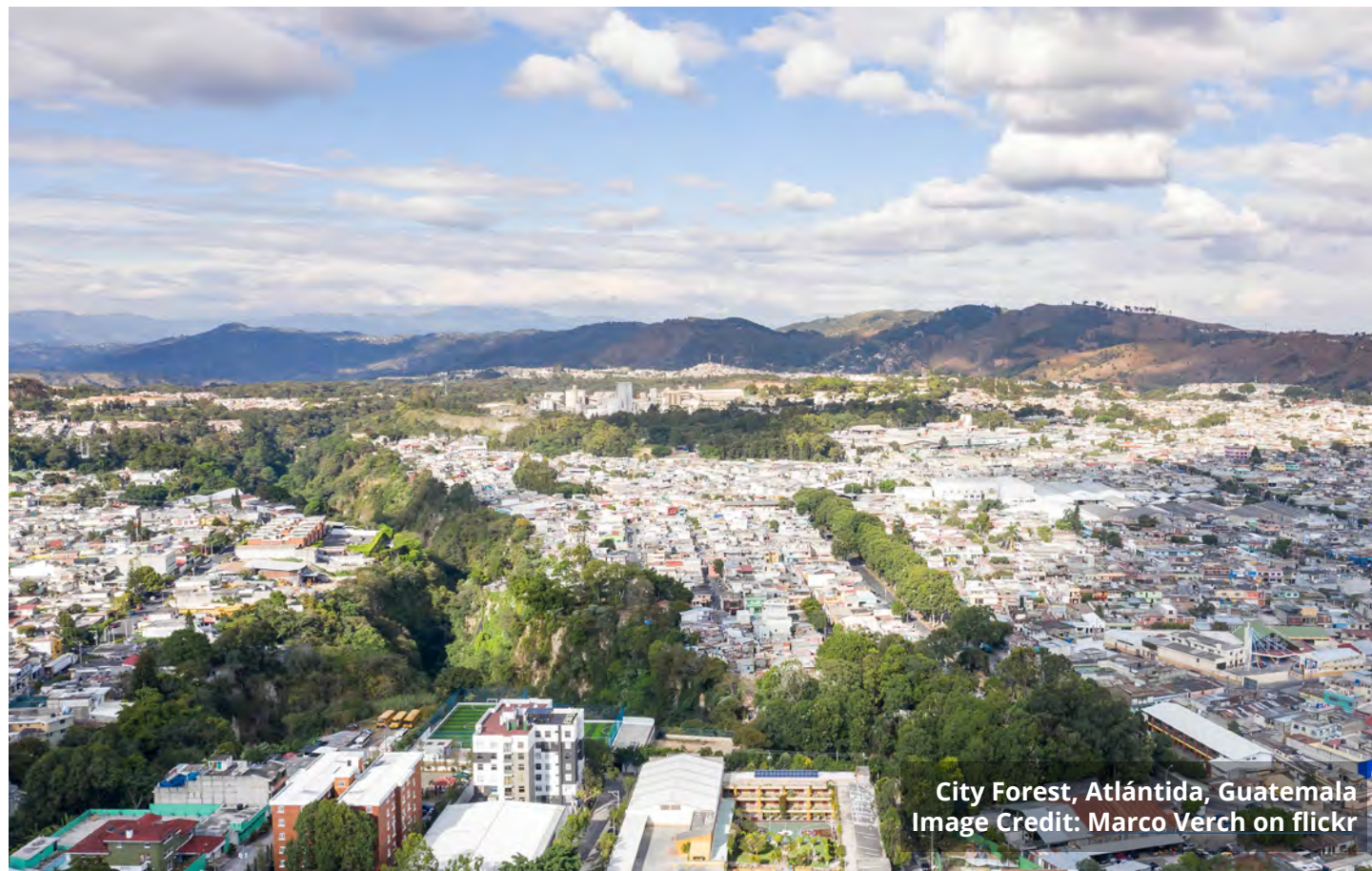
From City Tree Ordinances to Urban Forests

As understanding of the ecological and economic values of trees increases, so does recognition of the importance of urban forest management. Almost all cities in the U.S. have adopted tree management ordinances. Yet often cities are unable to allocate resources to urban forest management or implement even the simplest of management plans.

Comprehensive urban forest management should consider all trees and greenery across the jurisdiction to adequately address



View of the skyscrapers of Manhattan through the trees on Madison Square Park in New York City
Image Credit: Drop of Light on Shutterstock



City Forest, Atlántida, Guatemala
Image Credit: Marco Verch on flickr

a diverse landscape held by numerous land owners. Effective urban forest management must necessarily go beyond simple tree care ordinances to encompass a strategic forestry plan based on the heterogenous characteristics of the city and its inhabitants.

Successful urban forest management plans require workable tree ordinances that give broad discretion to those overseeing urban forest development. Those tasked with forest management should create a strategic “Green Infrastructure Plan” based on research conducted in the given urban area.

This research should include substantial public outreach to

members of the community to gauge their interest in promoting urban forestry and their knowledge of its benefits.

The plan should include management’s strategy, its goals and a timeline for achieving the goals. The plan should be flexible and able to adapt to the changing circumstances of the city.

The Urban Forest Planning Guide provides step-by-step instruction to cities that want to develop their own “Urban Forest” or “Green Infrastructure Plans” based on insights from cities at the forefront of urban forest planning.

Jess C. Stevens, J.D., is a recent graduate of the University of Virginia School of Law



Pre-Vernal BeltLine
Photo Credit: Thomas Cizauskas

A Forest Runs Through It: Atlanta, Georgia's BeltLine Arboretum

By Tim Beatley

The story of Atlanta's BeltLine is one well known to many and its success with the public so far has been huge. Eventually it will consist of a 22-mile loop around the center of Atlanta, utilizing historic railroad corridors to create an impressive multi-use trail system and (eventually) light rail transit. Few may know the story of the [BeltLine Arboretum](#), however, and the way this linear forest is shaping up to create an experience of nature for visitors to the trail.

The brainchild of Trees Atlanta Co-Executive Director Greg Levine, the idea was to convert the BeltLine into a unique, linear arboretum, bringing a biodiverse, bird- and wildlife-friendly forest to the center of the city, and making the

experience of walking or biking along the BeltLine a profoundly more natureful one. Trees Atlanta raised \$300,000 to fund the preparation of a concept plan that remains the guiding vision. A decade later the Arboretum consists of about 9 miles of the BeltLine's completed 10 miles or so, with Trees Atlanta planting a diverse palette of native trees and shrubs, as well as meadows and prairies in some locations.

According to Levine, the goal was in part to convert the BeltLine from a kind of "glamorized walking sidewalk," to a more nature-rich, natural experience, with the ability to perceive seasonal changes, to hear insects and other natural sounds in the evening, and to see and experience birds and wildlife.

To Levine this is about showing "how you can have a different kind of landscape in the city." Instead of the usual reliance on Bermuda grass, exotic shrubs and maybe two or three different species of trees, the arboretum is much different: there are hundreds of species, and a landscape supporting impressive biodiversity. A study by a researcher at Emory University of the Arboretum's native prairie found a much higher diversity and abundance of bees (7.8 and 3.5 times respectively) compared with areas planted in Bermuda grass.

There has been an emphasis on utilizing native trees and plants throughout, something Levine tells me has carried over into the planting plans for new

development or redevelopment nearby. As Levine explained, the goal of the arboretum is certainly to connect Atlantans to nature, but also "to be able to bring part of the BeltLine home."

There is little question that the arboretum has helped to educate about native plants and trees, and there are new housing projects nearby that have used mostly native species in their plantings. Levine mentions the Ponce Market as a positive example of a redevelopment project, right on the BeltLine, using mostly native plants.

These trees and greenery greatly enhance the quality of the Beltline as a pedestrian and public space. Nature helps propel us outside, helps to make the experience of walking more enjoyable. And as cities continue to heat up, arboretums like this one will help with essential urban cooling.

The BeltLine, including the arboretum, has been a phenomenal success. Some 1.7 million people use the eastside trail, not bad for an entire metro area of 5.6 million. Trees Atlanta is now fundraising for the next five miles of the Arboretum. Trees Atlanta has a big task caring for and maintaining all the trees on the trails, as well as coordinating volunteers, and training Arboretum docents who give guided tours.

Preserving the city's vaunted tree canopy continues to be a major challenge (Levine tells me it has been in decline, likely down to 47% or even less). More trees



BeltLine Biodiversity
Photo Credit: JD Brown

need planting, more forested lands need to be protected, and trees need to be more effectively taken into account and preserved during the process of development.

The city's tree ordinance is in revision and Levine is hopeful that it will emphasize efforts to take trees into account early in the development process. He cites the example of a new library where it was not until late in the design that the community realized the design would result in the cutting down of five large shade trees. With the right process, and with a greater commitment to trees, Levine

believes, this kind of outcome can be avoided in the future.

"Development needs to work within these [tree protection] parameters," Levine says, "and there is still a way to make money." Protecting trees will require "a line in the sand," and a stronger tree code is something a majority of Atlantans strongly support.

Resources:

Trees Atlanta. Atlanta Beltline Arboretum. <https://www.treesatlanta.org/programs/atlanta-beltline-arboretum>.

The Architecture of Trees

Review By Sean Geygan

Nearly four decades following its original publication in 1982, the new edition of “The Architecture of Trees” by Cesare Leonardi and Franca Stagi was released last year by Princeton Architectural Press. As a “scientific tome” of tree knowledge, it represents the authors’ intent to express a deeper understanding of, and nurture a closure relationship with, our chlorophyllic friends.

As architecturally trained students from Italy, Leonardi and Stagi recognized the inability to design parks without deep tree knowledge. That compelled Leonardi’s diagrammatic explorations. His obsessive-to-detail quill-pen illustrations, depicted through 550 plates, span 212 species (and 24 varieties) are. These were all drawn at 1:100 scale and are presented at the same.

The rigorous act of drawing revealed minute but undeniable traits of trees. As was then still is now, the act of drawing trees “allows one to consider and incorporate the various features (the size and shape of the trunk, the branches, their density and



size, and the foliage) different examples of a tree might have, and second, it makes it possible to isolate a tree from its surroundings.”

Stagi and Leonardi were impressed by trees for their architectural form. It inspired the duo’s approach to park design: open space ought to be designed “not to the measure of man, but to the measure of trees.”



Further scientific analysis of trees include the authors’ shade projections, presented in the re-issue as refined CAD diagrams, and their study of foliage color over four seasons, which have been reconstructed in this edition to match the documents in the Stagi and Leonardi archives.

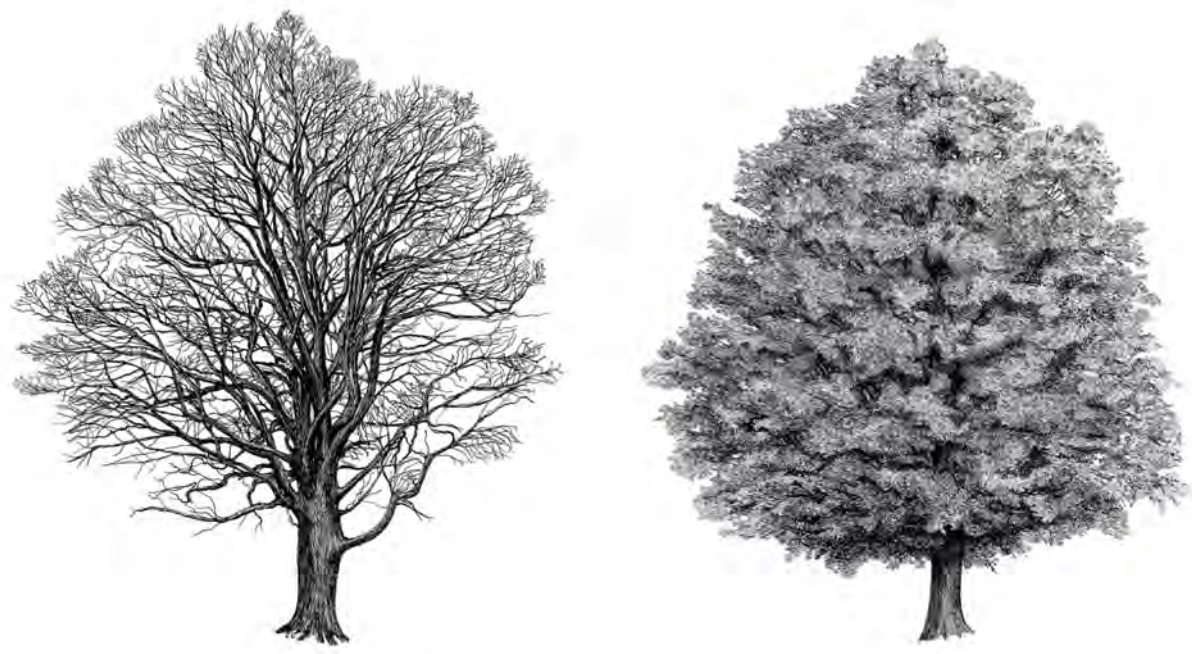
In their practice, shade analysis was elevated as a part of landscape design. They allowed the number, type, and position of tree plantings to be guided by where those trees would project their shadows onto the earth. Further still, the designers considered how sunlight penetrates a thick-leaved, mature tree differently than the bright green leaves of the same tree when young.

For Stagi and Leonardi, annual evolution of trees’ foliage was a delightful reminder of the progress of life and a reflection of the human experience of place. Varying day-to-day and across changing

seasons with shifting leaf pigments, a tree’s foliated appearance reflects important distinctions among forms and places.

This compendium of aesthetically beautiful tree diagrams serve as a reminder to the complex, living experience of plants and our neighborly relationship to them that defines the distinct quality of any planted landscape.

Cesare Leonardi and Franca Stagi (2019). *The Architecture of Trees*. Princeton Architectural Press.





To Speak for the Trees: My Life's Journey from Ancient Celtic Wisdom to a Healing Vision of the Forest

Review by Tim Beatley

I first encountered Diana Beresford-Kroeger, Irish-Canadian botanist and conservation scientist, on a medicine walk that she was leading through High Park in Toronto. I was not planning to attend; it was something I heard about at the last minute. I am very glad that I did, as it was an initial introduction to the wonders of trees as seen through the eyes of an unusually passionate and knowledgeable lover of trees. I learned many things I did not know about trees on that short walk and it left me wanting to learn more about both the science and ancient wisdom of trees she has been collecting and sharing. Much of this wisdom is here in her beautifully written memoir of a remarkable life's journey of studying and loving trees.

Beresford-Kroeger recounts with eloquence the progression of her discovery of trees and nature, and of her remarkable and diverse career of

research, writing and advocacy on behalf of trees and the natural world. Beresford-Kroeger's story is one of personal growth and discovery, as she learns from her elders the ancient wisdom of trees and the natural world, spending formative summers in her ancestral homeland of the Lisheens Valley (County Cork, Ireland).

The book recounts with emotion her moves from Ireland to America (briefly) and then later to Canada where she ultimately settled and has spent the last four decades. Her work on behalf of trees is remarkable and multifaceted. She and her husband transformed a 160-acre farm into a conservation arboretum and hands-on research station. Her research and advocacy take many different forms from writing books to filmmaking (the latest of which is the film *Call of the Forest*) to activism, especially on behalf of indigenous

landowners who she greatly admires and respects for their committed stewardship.

There is much joy and delight here, especially around the magic of trees. But there is also sadness. Beresford-Kroeger's is a bittersweet life journey, born into British aristocracy, she lost both her parents at the age of thirteen, ending up sent by the courts to live with her uncle. Thus began a "wardship" that would shape the rest of her life and help ignite a passion for trees and the natural world. Spending her summers in Lisheens Valley, County Cork Ireland, her relatives teach her about the ancient wisdom of plants and trees.

Another sadness arises from the realization that few trees and forests remain in Ireland. She finds herself learning the story of an ancient woodlands culture that essentially no longer exists. The reasons extend back in time to the 500-year British occupation and genocide: active deforestation became, she tells us, a weapon to control and subjugate. As she later navigates university and academic life (eventually obtaining a PhD in Biology from Carleton University in 2019), she also realizes how little value modern science places

on the ancient knowledge of her ancestors. She also confronts the reality that she may be the last generation to have obtained this ancient learning.

Nevertheless, she works to find ways to merge and blend ancient knowledge with modern science, and the book itself is evidence of the success of this. It is at once a celebration of the ancient ways and history of a largely extinct woodlands culture (Ireland), and a modern story of her discovery and work on behalf on a very-much alive Canadian forest ecology and culture.

A dispassionate scientist or cataloger of trees she is not. She is an unabashed lover of trees, and, as I recall from the medicine walk I attended, she is a more than occasional hugger of trees!) She urges that we need to engage in "loving trees as people," something consistent with the ancient Druid view of the intrinsic value of all things in nature. "It's not hard to love something so huge and magical," she says. And as is true for many of us, she notes, "trees were some of my oldest friends."

A focus of the book, and of her life, is understanding the healing power of trees and

forests. She recounts, throughout the book, the many uses of trees used to treat various ailments and to promote health among ancient people. The woodlands she says are “our collective medicine cabinet.” This traditional knowledge is increasingly confirmed and validated by science she says. She argues persuasively in the book (and through the example of her life and advocacy) that it is indeed possible and necessary to productively merge these perspectives.

This is also one of the recurring tensions in the book; a tension between the modern scientific view of trees and nature that she encounters in the academic setting and the ancient knowledge and more spiritual view of trees. In academia she finds plenty of sexism but also a discounting of the spiritual: “among academics, a scientist



was expected to know better than to trust the knowledge of Indigenous woodland cultures.”

She tells of experiencing her own first medicine walk, led by her great-aunt Nellie. Picking out plants here and there, Nellie would tell of their medicinal uses: “she highlighted species after species; she had a cure for diseases I have never heard of -- mental illnesses, digestive upsets, heart problems and skin troubles.” She tells the story of her own personal confirmation of the benefits of this plant knowledge as she sees firsthand how an ancient cure for warts works. Such ancient knowledge about trees and nature is not to be thought of as superstition but rather as practical learned insights, borne of intense observation over time and often provable through the methods of science. Beresford-Kroeger’s is a story about the handing down of this ancient knowledge and about the affirmation of the importance of this learned wisdom in a modern world.

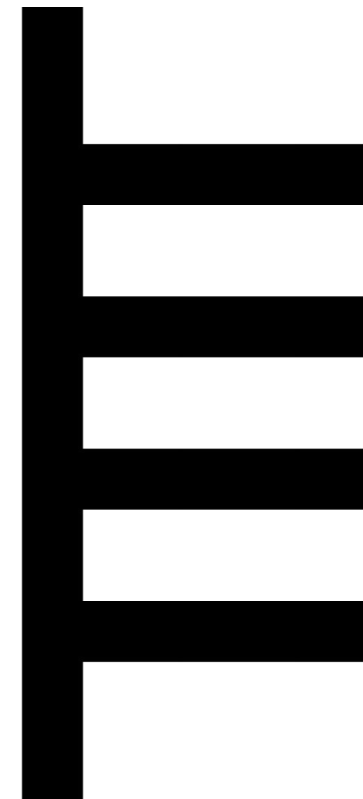
The latter third of the book (Part Two) presents a remarkable catalog of the ancient benefits, largely medicinal, of different trees. In a testament to the importance of trees to ancient Irish culture, this catalog is organized around the Ogham alphabet with each letter of the Celtic alphabet named after a tree. Here we learn, for instance that: wood from Pine trees is used as an antiseptic; Birch trees produce anticancer chemicals and pain relievers (and an ancient precursor to aspirin), as well as a treatment for urinary tract infections made from its leaves; Oaks produce tannins used to treat burns; Holly can be used to treat bronchitis and rheumatism; and groves of Willow are useful in treating depression and loneliness. Associated plants are no less potent: there is the healing honey from gorse and heather; a treatment for night blindness from eating elderberries; and the anticancer properties and immune system boosts derive from eating blackberries. It is hard not to be convinced of the medicinal values of trees and to wonder what other hidden antidotes, cures and generators of health and wellbeing might lie within our touch,

awaiting observation and discovery (or more likely have been discovered but have now been forgotten).

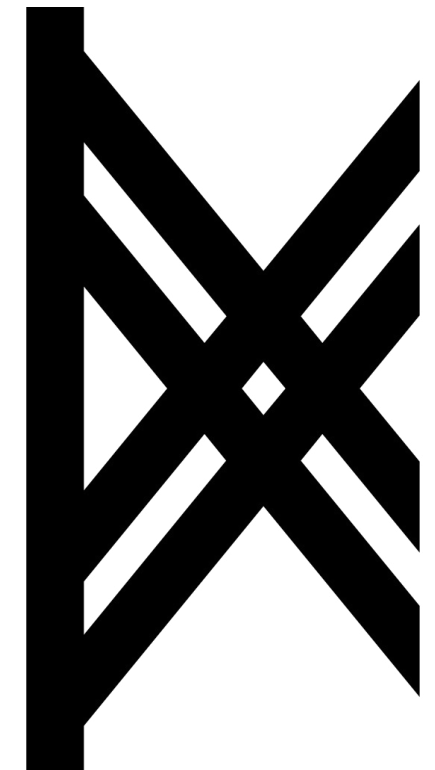
This is not a book about cities, though the lessons of care and love for trees, nature, and landscapes will find equal application there. If only we could treat urban ecosystems with the same reverence and attention she and her husband bestow on their organic farm. She sometimes describes the micro-ecology of trees using urban language. In describing the majestic older Oak, she notes that “each tree is a metropolis for insects, butterflies and pollinators.” Bio-cities of life within larger human designed bio-cities. She also speaks of efforts at bioplanning, working to create a bioplan for the Canadian capital of Ottawa, for example. There is little doubt that we need the kind of rigorous research and science she brings to bear

in talking of trees, and the many benefits they provide, but perhaps more than anything else we need some of the magic and mystery she conveys, and a sense of the loss we would all feel if they (an intentionally chosen pronoun) did not live among us.

Diana Beresford-Kroeger (2019). *To Speak for the Trees: My Life’s Journey from Ancient Celtic Wisdom to a Healing Vision of the Forest*. Random House. <https://www.penguinrandomhouse.com/books/575305/to-speak-for-the-trees-by-diana-beresford-kroeger>.



Ogham letter sail for “willow-tree”



Ogham letter ifin for “pine”

Our Wild Calling

Review by JD Brown

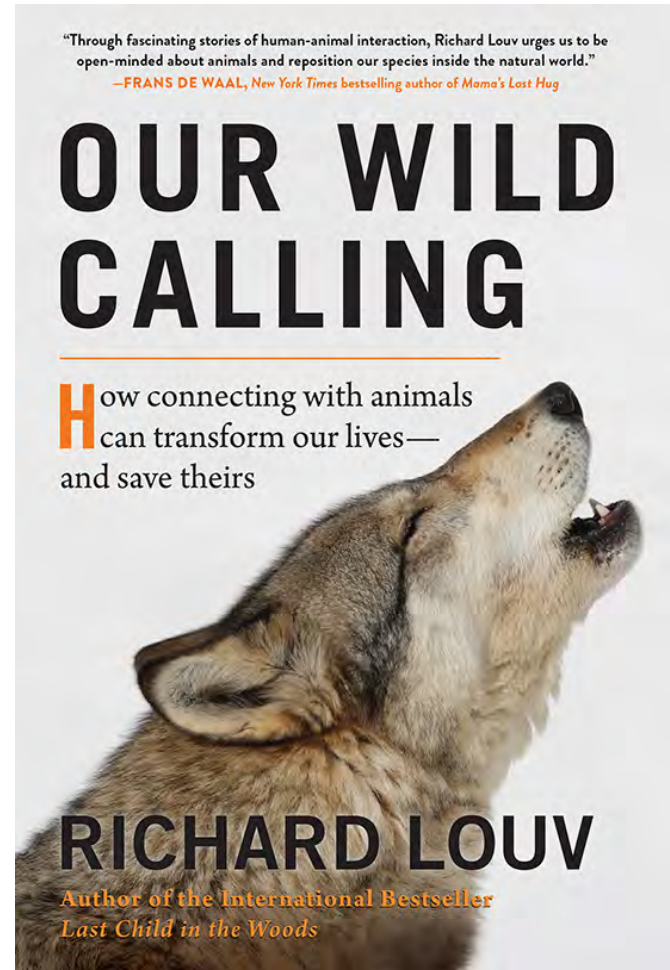
I had the opportunity to hear Rich Louv speak at a MODA Health conference in Portland, Oregon, in May 2018. He spoke in appreciation of Tim Beatley and his choice to pursue an optimistic future. Louv finds that such optimism is in too short supply; especially, for a younger generation, which has been told since day one that it is too late. In his most recent book, *Our Wild Calling*, Louv explores how our innate connection with animals, often in the wild places they call home, can provide a such a spark of promise.

At the outset, Louv sets forth two main reasons to explore our connection with animals. One is human health and well-being. The second is the accelerating state of species extinction. A challenge that requires “an inescapable network of mutuality” between humans and our wild neighbors. This mutuality, in part, is built through an appreciation of beauty and its expression through art: “To fully protect anything, we must know it, love it ...” As well, an appreciation of mystery and awe is required, which cannot be reduced to just numbers and the purely rational. It requires an understanding of “the inherent wisdom of interconnected, repeating patterns found in nature.” To the extent that we can apply this pattern language to the design of nature-friendly cities, we create the potential for cities to simultaneously provide a haven for urban biodiversity and to reduce our own species’ loneliness.

In part, this requires following the wisdom of Indigenous people that reject the dualistic understanding of nature and culture and dissolve human and non-humans into a single sphere of relationships, a process called “co-becoming.” It requires recognizing and revering the rights of nature itself. In return, from our non-human fellows, we learn pro-social behavior and form a mutual contract to co-evolve. Our connection with animals provides a strategy for positive mental

and physical health. They provide a power for optimism, which as Louv has noted is in too short supply.

Rich Louv (2019). *Our Wild Calling*. Algonquin Book. <http://richardlouv.com/books/our-wild-calling>.



The Emergence of Biophilic Design

Review by JD Brown

As part of the *Springer Cities and Nature series*, Jana Söderlund traces the roots biophilic design from its inception through its continued growth into a global movement. As biophilic design pioneer Judith Heerwagen identifies in her forward to the book, Söderlund demonstrates that “biophilia is not just a design issue. It is also a social movement built around the idea that connection to nature is a basic human need.”

Söderlund applies the framework of social movement theory to demonstrate not only the emergence of biophilic design as a movement, but also charts the course for how biophilic design can continue its trajectory into the latter stages of social movement evolution: from coalescence to mainstream. As she identifies, there are existing barriers to continued growth in the acceptance and application of these ideas, from undocumented benefits to a lack of political will and understanding. But this book documents the burgeoning global community that is building the tools and making the case to overcome those barriers.

As recounted within, Jana Söderlund has been a partner in the Biophilic Cities Network since its inception. She is building the movement in her home city of Fremantle, Australia, and building a broader coalition of regional partners through her leadership with Biophilic Cities Australia. With this book, she has also contributed to the important literature that is the foundation for this social movement.

Jana Söderlund (2019). *The Emergence of Biophilic Design*. Springer. <https://www.springer.com/gp/book/9783030298128>.

Springer. Cities and Nature series. Peter Newman and Cheryl Deshna (Eds.). <https://www.springer.com/series/10068>.

