Planting the Living City

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Best Practices in Planning Green Infrastructure—Results From Major U.S. Cities

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Problem: Critics have problematized infrastructure for its inability to keep pace with the rising social and ecological impacts of urbanization. Researchers identify urban green infrastructure (GI), including urban forests, as an important strategy for providing public goods and increasing resiliency while reducing ecological footprints and social inequity in metropolitan areas; however, realizing these benefits through planning is still uncertain ground, as most contemporary urban GI endeavors in the United States are small, individual projects rather than integrated, community-wide efforts. This underinvestment has left planners with little experience in developing GI at a metropolitan scale.

Purpose: We address this deficit in infrastructure planning by studying planning's role in advancing large-scale, urban tree-planting initiatives (TPI) in eight major U.S. cities and one metropolitan county. In this study, we explore stakeholder perspectives on successes and setbacks in TPI planting, stewardship, business, and outreach plans. From these perspectives, we identify possible best practices that can better inform future efforts to plan GI on a metropolitan scale.

Methods: From a review of the literature, we identified ideal planning elements researchers and practitioners considered fundamental to well-planned, urban forestry-based GI programs. We interviewed key stakeholders ($n = 86$) in eight major cities and one metropolitan county (New York, Los Angeles, Houston, Baltimore, Seattle, Denver, Albuquerque, Sacramento, and Salt Lake County), using multiple-choice and open-ended questions to explore their perceptions of TPI successes, failures, and opportunities for improvement. We used this data to compare TPI planning and implementation with ideal urban forestry and GI planning elements, to identify TPI best practices, and to locate TPI program elements such as business and stewardship planning in relation to traditional infrastructure. We discuss these findings in light of opportunities to bring GI into the mainstream of metropolitan infrastructure planning.

Results and conclusions: We found that cities employed a spectrum of planning strategies to advance TPI, ranging from highly institutionalized, data-driven initiatives to decentralized, grassroots efforts. Participants viewed TPI as bringing GI to the mainstream; however, uncertainties in funding and long-term stewardship belie this perspective. Lacking access to traditional infrastructure financing, several TPI used creative development and contracting strategies to maintain program funding and momentum, while others stagnated. Additionally, programs lost momentum when mayors who launched TPI were not reelected. Successful underfunded initiatives focused on community-level engagement. However, institutionalized, diverse funding structures and robust, agency-level commitment to maintaining and expanding urban forests were considered most effective in advancing urban forestry-based GI. Overall geographic distribution of TPI, and the relatively sophisticated financial and institutional approaches achieved by New York and Seattle, provide insight into possible national strategies to advance metropolitan-scale GI. Similarly, Los Angeles's and Baltimore's use of focused corporate sponsorship and community engagement to advance underfunded programs could inform international GI efforts.

Takeaway for practice: Through large-scale TPI, planners are beginning to engage in planning metropolitan-scale GI as a conscious strategy to address urban ecological issues and deliver public goods. Initiatives benefit from being launched early in an administration's term. Further, detailed, data-driven planting plans, combined with diversified funding sources and the institutionalization of tree-acquisition in the capital budget, can enable TPI to establish a) long-term contracts, b) control over supply chains, and c) stability in recessionary times. Contracting with grassroots and advocacy organizations to perform education and fieldwork can provide means for underfunded programs to maintain momentum toward meeting TPI goals; however, accessing traditional infrastructure financing mechanisms and institutionalizing stewardship plans are fundamental to long-term expansion and maintenance of investments in metropolitan GI.

Unprecedented urbanization is placing rising demands on local and global ecosystems. In response, efforts to stem ecological decline and establish sustainable communities are adopting an increasingly urban focus

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(World Bank, 2009; Worldwatch Institute, 2007). Providing public goods to urban populations and increasing the resiliency of metropolitan areas while reducing urban ecological footprints and social inequity are central to this focus (Novotny & Brown, 2007; Rees & Wackernagel, 2008; Young, 2010a, 2010b).

Researchers have identified green infrastructure (GI) as an important means to meet these goals. Although defined across a range of scales, GI is seen by many researchers as encompassing both natural and socially engineered green space, resulting in "an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife" (Benedict & McMahon, 2006, p. 1; see also Dunn, 2010; Tzoulas et al., 2007).

Researchers and practitioners recognize urban forests as a key GI element (Amati & Taylor, 2010; American Planning Association [APA], 2009; Konijnendijk, 2010; Konijnendijk, Nilsson, Randrup, & Schipperijn, 2005; Schilling & Logan, 2008). They define urban forests as "the aggregate of all community vegetation and green spaces that provide a myriad of environmental, health, and economic benefits for a community" (Sustainable Urban Forests Coalition, 2010). Urban forests contribute to GI by providing a spectrum of public goods, including the "psychological, sociological, economic, and aesthetic benefits trees provide society" (Helms, 1998, p.193).

However, realizing these benefits through planning is still a challenge. While APA asserts that urban forests should be at the forefront of the planning process, they also recognize that, "because urban forestry is an emerging discipline, its relationship to planning is still evolving" (APA, 2009, p.18). We investigate this relationship by exploring planning's role in developing large-scale, urban GI projects through interviews with key participants and informed observers ($n = 86$) of large-scale tree-planting initiatives (TPI) in eight major U.S. cities and one metropolitan county (Table 1).

In performing this study, we ask the question: what experience are major urban TPI providing city staffs and associated stakeholders in planning and executing GI on a metropolitan scale? We focus this inquiry on whether major urban TPI are engaging a broad scope of planning efforts to support their programs. We further explore stakeholders' perceptions of the level of development and success of these plans. Last, we discuss best practices that could inform future metropolitan-scale GI efforts.

Challenges in Planning GI

Managing urban forests as GI poses a range of planning challenges. The first regards scale. Most contemporary urban GI endeavors in the United States are "small, piecemeal patches created by individual developers rather than an integrated effort by the whole community…" (Novotny & Brown, 2007, p. xx). While large-scale, multi-city projects such as Fredrick Law Olmsted's park and parkway designs, Elizur Wright's urban forest reserves, and Ebenezer Howard's garden city ideas enjoyed prominence in the late 19th and early 20th centuries, their vision of planned, metropolitan-scale GI was largely discarded by the mid-20th century (Miller, 2000; Novotny & Brown, 2007; Rawson, 2010; Ricard, 2005). Contemporary cities such as Philadelphia and New York that factor GI into

Table 1. City tree-planting initiative launch dates, targets and performance.

City	Launch date	Planting goal (# of trees)	Planting goal (# of years)	Total trees planted (11/30/2010)
New York City	2008	1 million	10	379,170
Los Angeles	2008	1 million	"several"	250,000
Houston	2008	1 million	5	400,000
Salt Lake County	2007	1 million	10	150,538
Sacramento	2005	5 million	20	40,882
Denver	2006	1 million	19	191,366
Seattle	2007	650,000	30	125,000
Baltimore	2006	[a]	30	28,000
Albuquerque	2004	75,000	2	30,000
Totals		11 million		1,594,956

Note: a. The City of Baltimore set doubling the city's canopy cover (from 20% to 40%) as their goal, rather than the planting of a specified number of trees.

their urban water management system remain outliers to national norms. This underinvestment has left planners in the United States with little experience in developing metropolitan-scale GI.

The second challenge regards navigating diverse urban ecological dynamics and infrastructure needs (Berg, 2009; Donaghy, in press; Sites, 2007). Differences in climate, species, and disturbance regimes, joined by social variables in site history, culture, economy, and politics, hamper generalization. With investments in species and design elements too wedded to place to be easily transferable, local planning becomes critical in determining, developing, and sustaining community GI. Thus, a municipality's commitment to planning (rather than specific design strategies) in large-scale, urban GI programs may be the keystone to their success (APA, 2009; Dwyer, Nowak, & Noble, 2003; Niemela, 1999).

Still, these case studies' diversity represents opportunities to advance national and international GI planning. The initiatives' geographic distribution, and New York and Seattle's relatively sophisticated approach to addressing financial and institutional questions, provide initial insights into what might constitute national policy efforts toward advancing metropolitan-scale GI. By the same token, programs such as Los Angeles's and Baltimore's use of focused community engagement to offset lack of funding offer templates that could inform international GI efforts.

The Forest and the City

Urban forests are an arena where urban GI projects have transcended isolated, small-scale efforts. Eight large U.S. cities and one metropolitan county recently launched major TPI with pledges to collectively plant nearly 11 million trees. These initiatives promise to advance environmental resiliency and provision of public goods in these communities. They also offer a unique opportunity to explore planning's role in the development of large-scale, urban GI projects.

Urban forests represent a significant national and metropolitan GI resource. As Dwyer, Nowak, Noble, and Sisinni (2000) note, "with an average tree cover of 33.4 percent, metropolitan areas collectively support nearly one quarter of the nation's total tree canopy cover" (p. iii). Not surprisingly, urban forests play a significant role in GI systems by moderating water, climate, and air quality issues as well as enhancing quality of life and property values. In doing so, urban forests make considerable contributions to reducing public service costs and increasing capital accumulation.

Urban forests reduce flooding and mitigate erosion and pollutant discharges into waterways by intercepting rainfall and promoting soil infiltration (American Forests, 1997, 2002; Hirsch, 2008; Korhnak, 2000; Lerner & Poole, 1999; Xiao, McPherson, Simpson, & Ustin, 2000). The nonprofit American Forests postulates that increasing tree canopy cover in U.S. cities to 40% would add $100 billion to the $400 billion in storm water retention benefits that urban trees currently provide nationwide (American Forests, 2000).

Urban forests mitigate climate impacts by removing a range of gaseous pollutants and airborne particulates and, through shading, reduce the urban heat island effect and greenhouse gas emissions from power plants (Akbari, 2002; APA 2009; Daniels, 2010; Nowak, 2000). Researchers approximate that urban trees in the U.S. store 700 million tons of carbon as a long-term sink and annually sequester 23 million tons of carbon valued at $14.3 billion and $460 million respectively, depending upon climate, extent of canopy cover, forest age, and species (Nowak & Crane, 2002).

In addition to mitigating water and air quality issues and contributing to municipal cost reductions, forests add to metropolitan capital accumulation (APA, 2009; Benedict & McMahon, 2006; McPherson, Nowak, & Rowntree, 1994; Muldavin, 2010). Researchers estimate that GI enhances metropolitan property values between 10% and 30% (Donovan & Butry, 2008; Hamilton & Quayle, 1999; National Park Service, 1995; Petit, Bassett, & Kollin, 1995).

Research Questions

These advantages in environmental performance, cost savings, and capital accumulation underscore the importance of considering planning's role in advancing large-scale, metropolitan GI projects. Given this importance, the growing call to use GI to address metropolitan-scale sustainability issues, and the paucity of contemporary experience with such projects, we ask the following question: Are major urban TPI providing city staff and associated stakeholders experience in planning and executing GI on a metropolitan scale?

We address this question by inquiring:

1. Do stakeholders view TPI goals in traditional terms of tree replacement and beautification or in the broader context of advancing urban GI?
2. Are these cities engaging a broad scope of planning efforts to support their TPI? Do stakeholders view these efforts as well developed and effective?
3. Do these programs offer best practices that could inform planning future metropolitan-scale GI initiatives?

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Leading forestry and municipal planning organizations have articulated planning elements fundamental to successful GI implementation. These include an overall vision supplemented by planting, stewardship, business, and public awareness plans (APA, 2009; American Public Works Association [APWA], 2007a; Benedict & McMahon, 2006; Hubbard, 2000). Planting and stewardship are the actions necessary to initiate and sustain TPI. The tree-planting plan identifies tree species, neighborhoods, and sites selected for the effort. Stewardship plans outline activities necessary to sustain new plantings, including watering, inspecting, pruning, and pest and disease control.

Business and public awareness plans support planting and stewardship. While perception of urban forests in the United States often centers on aesthetic value, the incorporation of urban forests into the broader concept of GI requires "an entirely different model focused on trees as a wise public investment strategy…as a profit center" (APA, 2009, p. 30). As such, they require business planning that recognizes urban forests as legitimate equals in the realm of infrastructure funding. Both researchers and practitioners agree that this new status can only be supported if the spectrum of benefits trees provide, and the role of citizens and policymakers in maintaining them, is widely understood.

In response, researchers and advocates assert that long-term investment in urban forests requires commitment to making the program financially sound. Thus, they argue in favor of establishing a plan for sustained business administration activities, including fundraising, budgeting, personnel, and purchasing.

Since urban forests reside mainly on private lands, their success depends on educating the public about planting and maintenance benefits. A plan for public awareness, including outreach to different constituencies, reporting program accomplishments, and disseminating basic program information is vital to developing support for urban forestry initiatives (APA, 2009).

Researchers and practitioners advocate an integrated vision to guide these plans. While state and national forests in the United States have a relatively long history of comprehensive strategic planning that incorporates visioning, urban forests often suffer from fragmented goals, administrative structures, mandates, and responsibilities (Kilgore, Hibbard, & Ellefson, 2006; Kuchelmeister & Braatz, 1993; Sandstrom, Angelstann, & Khakee, 2006). However, academics and practitioners assert if the urban forest "is advanced to the forefront of the visioning or goal-setting process, it is far more likely that citizens and stakeholder attention will focus on how trees can serve vital functions in better managing stormwater, improving urban air quality, human health, and property values; enhancing walkability and the quality of urban life; and lowering building energy demand, among other benefits" (APA, 2009, p. 26).

Methods

City Selection

We chose to study TPI in eight major U.S. cities and one metropolitan county: New York, Los Angeles, Houston, Baltimore, Seattle, Denver, Albuquerque, Sacramento, and Salt Lake County. We selected these cities based on a national search for large-scale, urban tree-planting programs with mayoral sponsorship or endorsement. We performed an Internet search for leads and contacted six programs (Los Angeles, New York, Albuquerque, Sacramento, Denver, and Salt Lake County). Through interviews with leaders from these six cities we added three additional cities: Houston, Seattle, and Baltimore.

Interview Population

We interviewed a similar set of individuals knowledgeable about the TPI in each city. Interviewees included

- the mayor (or mayor's staff);
- the TPI director and other team members (e.g., foresters, publicists);
- major nongovernmental organization partner(s) (e.g., financial and tree advocacy organizations);
- corporate partner(s); and
- knowledgeable non-partners (e.g., retired city staff, nursery people, academics, and arborists).

We administered 86 in-person or telephone interviews, recording the 90-minute interviews digitally and by note taking. We transcribed the interview notes and sent them to the interviewees for review, editing, and verification (Gillham, 2000; Yin, 2009; Yow, 1994).

Interview Instrument

The interview contained three sections consisting of approximately 20 questions each. The first section focused on executive policy management, program vision, and goals. The second section focused on program planning, with subsections on tree-planting, stewardship, business, and outreach plans. The third section addressed program accomplishments and setbacks.

The interview consisted of Likert scale and open-ended questions that asked interviewees to rank the robustness and effectiveness of the planning and execution of their city's TPI (Babbie, 2005). We used a 4-point scale with balanced keying (equal number of positive and

negative choices) in order to reduce acquiescence bias. The interview presented forced choice questions (no neutral option) in order to reduce central tendency bias; however, interviewees were given a "don't know" option in order to support the accuracy of the scored responses. The open-ended questions added richness to the Likert scale assessments, offering interviewees the opportunity to explain the details of their choices.

Data Analysis

We assigned numerical values and tabulated results to derive a Likert scale of mean response values. We used these values to compare TPI planning and implementation with ideal urban forestry and GI planning elements and reviewed open-ended answers for repeating themes. We analyzed these themes to identify TPI best practices and locate TPI program elements such as business and stewardship planning in respect to traditional infrastructure. We then discussed these findings in light of opportunities to bring GI into the mainstream of metropolitan infrastructure planning.

Findings

TPI Program Goals

We sought first to establish whether stakeholders conceptualized TPI goals in traditional terms of tree replacement and beautification, or in the broader context of advancing sustainability through GI. Although respondents emphasized different contributions of the urban forest, they identified six TPI goals more frequently than beautification (Table 2).

Restoration and expansion of the urban tree canopy dominated (57/86) interviewees' articulation of TPI goals and was often connected with broader, GI objectives; one third (32/86) placed city tree-planting goals within overall sustainability or quality-of-life objectives. Interviewees also identified climate mitigation (28/86) and urban water and air quality (14/86 and 10/86, respectively) as important objectives of their city's tree-planting program. Eighteen respondents also saw establishing a new civic relationship to the urban environment as a central feature of their city's TPI. As one interviewee noted, "Its goal is to get city residents to understand that as [urban citizens]: 'you live in an urban forest.'" Urban beautification and considerations of competitive advantage were also mentioned by respondents, but to a lesser degree (9/86 and 8/86, respectively).

TPI Planning Scope

A second study goal was to assess the range and level of plan development supporting each TPI. As noted from the literature review, well-developed GI programs should encompass planting, stewardship, business, and public awareness plans. We asked interviewees to evaluate the level of development and effectiveness of these plans in their city's TPI.

Table 2. TPI goals identified by interviewees.

Goals identified by interviewees	Interviewees identifying goal
Restoring and expanding tree canopy	57
Increasing community sustainability	32
Climate mitigation	28
New civic environmentalism	18
Water quality	14
Air quality	10
Beautification	9

Tree-Planting Plans. Tree-planting plans identify tree species, neighborhoods, and sites selected for the effort. Respondents in New York City reported the closest proximity between planning and effectiveness. Salt Lake County and Seattle reported the lowest mean values for their planting plans, with Seattle respondents reporting effectiveness that exceeded plan development and Salt Lake County respondents perceiving the greatest planning/effectiveness gap (Figure 1).

New York City respondents connected concerted data gathering to their tree-planting plan's high level of development and effectiveness. Environmental and social data such as canopy cover, traffic, air quality, and asthma rates informed this process and were repeatedly mentioned as the basis of the city's plan. New York interviewees nested the tree-planting plan within the city's master plan (PlaNYC). One interviewee's summation reflected this enthusiasm for data-driven planning:

> We know numbers of how many trees have been planted in public, private, street tree, and reforestation areas. We have great data from the [U.S.] Forest Service that we use all the time. We also have a 100 percent tree census. We know the number of trees per linear mile of street. We know how well census tracts are planted. We were able to calculate where people are and where trees are so we can target plantings where there is a low ratio of trees to people.

Salt Lake County interviewees perceived the greatest difference between plan development and effectiveness. Respondents agreed there was little commitment to developing a citywide tree-planting plan. No new field research

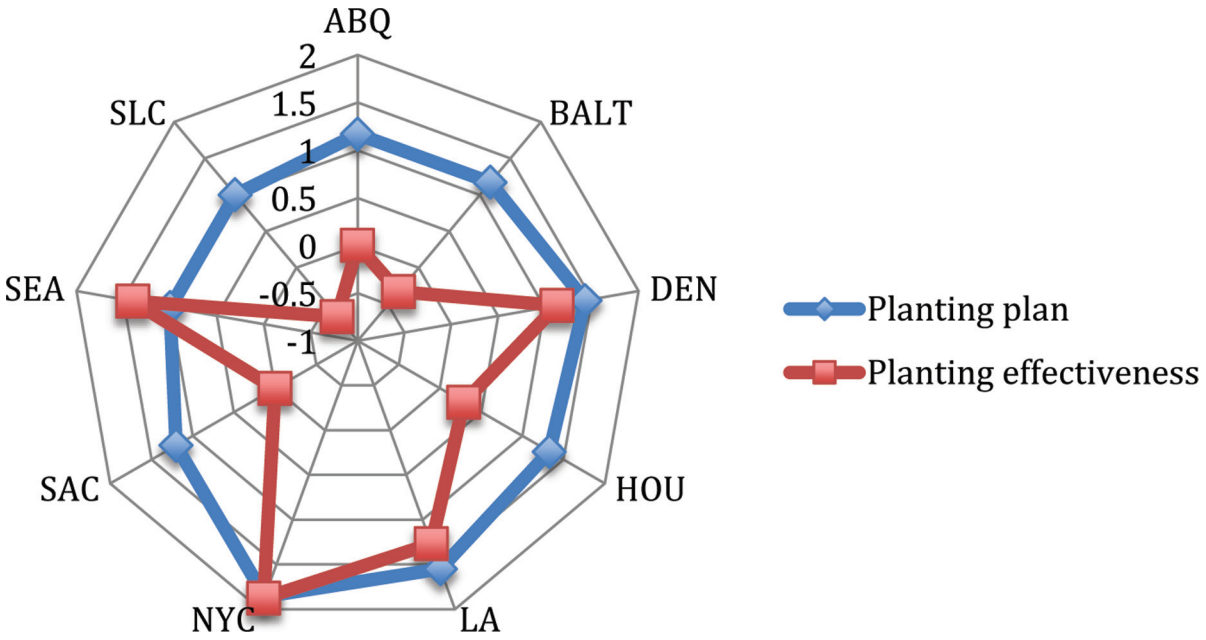

Figure 1. Perceived levels of tree-planting plan development and effectiveness.

(Color figure available online.)

was initiated. Rather, a respondent explained, the planning process "was to do a survey with existing or acquired documents that showed where the present canopy was and where a lack of vegetation was and to try to…develop some strategies to address those areas."

Salt Lake respondents identified underinvestment in the planting plan as its primary limitation. As one respondent noted:

> The only plan that we had was a very rough outline…to say that if we are going to do this, what the first few years would look like. Most of that would be around...finding resources and forming partnerships with nurseries because we can't buy any trees.

Seattle respondents ranked their tree-planting effectiveness above their investment in planning. While the city's Urban Forest Management Plan recommends rather than directs actions to restore Seattle's urban forest, interviewees pointed to the variety of existing planting programs as the source of the city's success in improving its urban forest. They describe a robust culture supportive of rectifying the city's 50% decline in canopy cover since 1972. This respondent's explanation was characteristic:

> It involves the successful implementation of programs with many different agencies. [The Department of] Transportation is very exact on their requirements with street trees. [The] Parks [Department] is interested in tree retention and restoration projects.…Urban forest tree-planting practices are implemented by each independent agency.

Stewardship Plans. Stewardship plans identify activities that will sustain new plantings, including watering, inspecting, pruning, and pest and disease control. While respondents across all cities agreed that tree care was vital to ensure long-term TPI viability, there were diverse perspectives on investment in stewardship planning and effectiveness (Figure 2).

Los Angeles interviewees reported the closest alignment between stewardship planning and effectiveness, while New York City interviewees registered the greatest difference. Houston interviewees, however, reported the least investment in stewardship planning but the highest mean for effective stewardship.

Los Angeles respondents credited stewardship agreements and incentives with the program's successful stewardship planning. An interviewee explained, "The majority of [our] tree planting is being done through nonprofits and they are required to ensure that trees survive for a period of time after planting…or they do not get paid for those trees." Another respondent elaborated, "Any nonprofit that plants [for the city] has a two-year follow-up on that tree. If trees fail it reflects on us, so we will not let them plant [for us] again. It has been a successful policy."

Los Angeles respondents reported interest in permanently transferring stewardship responsibilities after the initial two-year contracts expire.

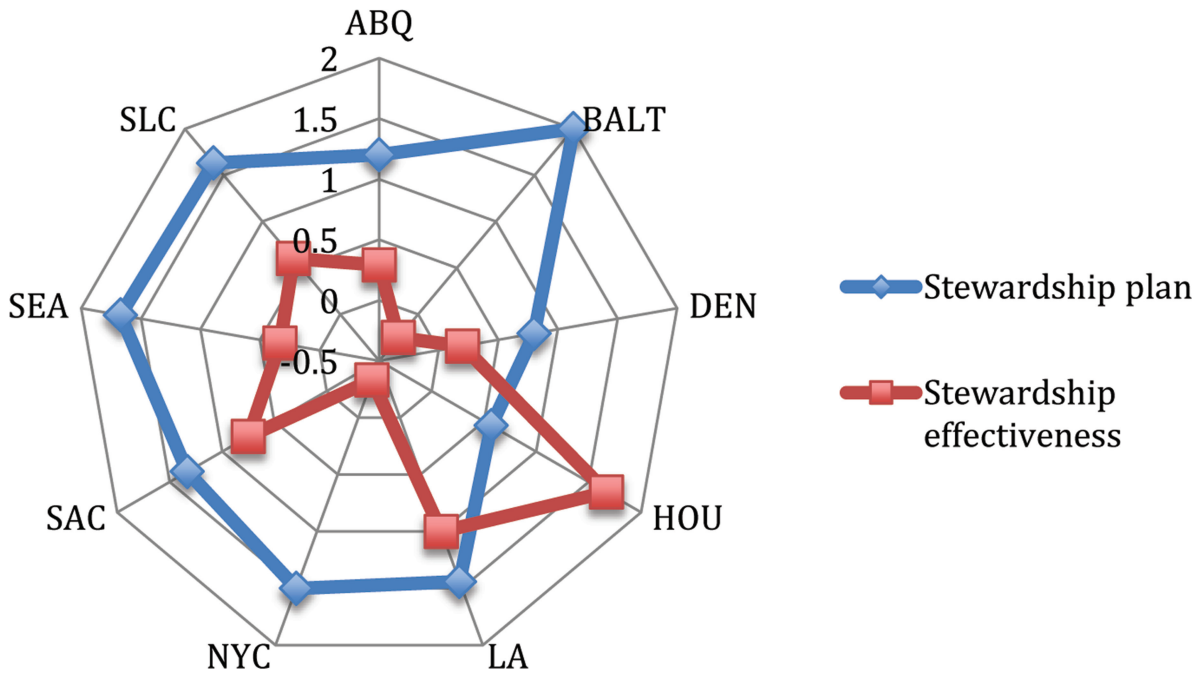

Figure 2. Perceived levels of stewardship plan development and effectiveness.

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New York City respondents identified maintenance budget cuts as impairing their stewardship plans. In response to these cuts, they adopted a similar strategy of shifting stewardship responsibilities through contracting and greater volunteer engagement. City contracts for tree planting have two-year stewardship guarantees, and contractors must replace trees that don't survive. Respondents agreed that contract requirements have improved tree care. As one interviewee noted, "We spend our money on supervising the contractors rather than spending it on equipment."

In addition, the city launched the Stewardship Corps to build neighborhood stewardship capacity. Collaborating with each borough's botanical gardens and tree-related nonprofits, the city offered free stewardship workshops and online tracking of volunteer tree care to "show the administration the number of hours of free tree-care being gained by the investment."

Recruiting and mobilizing citywide volunteer stewards, however, has proved challenging. Respondents described well-attended stewardship classes but inadequate volunteer numbers to match the scale of stewardship needs. A respondent explained: "Our stewardship activities and events are very effective but our overall stewardship has been ineffective…motivating stewardship is difficult. I mean, how do you get 15 gallons of water down to a tree when you live in a high rise?"

Respondents hoped to elevate citizen stewardship. As a city hall staffer noted, "Something we will do in the next iteration of the plan is the creation of a more robust Stewardship Corps. I think that this can be accomplished. New York City has a good history of recruiting outside partners in keeping our parks maintained."

Another approach, New York respondents agreed, is institutionalizing stewardship by moving maintenance funds from the general fund, where they are more vulnerable to cuts, to the capital budget, with tree procurement. Unifying the program under the capital budget, they argued, would better sustain GI investments.

Houston respondents, while reporting little investment in stewardship planning, indicated a high level of on-the-ground tree care. Noting Houston's perennial heat, respondents reported a normative sense about what trees require in order to survive in that environment. Interviewees often referred to it as a rule of thumb in Houston. This interviewee's response was typical: "The city doesn't have a written stewardship plan. But, there is widespread adherence to the 'rule of thumb' around here: get a newly planted tree through for two summers and it will survive."

Houston institutionalized this understanding in its tree-planting contracts. Like Los Angeles and New York City, organizations selected to implement the city's tree-planting projects are required to maintain the trees for two years.

While there is consensus that these efforts provide a basis for tree care in the city, some respondents expressed concern that longer-term stewardship is neglected. As a

Houston respondent noted, "The first five to ten years of the tree's life you don't have to do much. But then there is a pruning effort that you need to do and there is no plan for that at the city-level; there needs to be a longer-term stewardship program for a TPI of this scale."

Business Plans. Plans for sustained TPI business administration include fundraising, budgeting, personnel, and purchasing activities. New York City respondents ranked their business planning efforts most highly, and closest to their perception of business administration effectiveness (Figure 3).

Respondents described a TPI business plan rooted in the citywide plan for sustainability (PlaNYC). Since the TPI is a joint effort between the city and the nonprofit New York Restoration Project (NYRP), budgets rely on the city's contribution as well as on private fundraising by NYRP and the Mayor's Fund, the mayor's separate nonprofit fundraising vehicle. This respondent's enthusiasm was typical: "Fundraising has been very successful and the Mayor's Fund has done the lion's share. The mayor personally gave $5 million dollars through his foundation and David Rockefeller matched his contribution to the initiative. Sting [the musician] gave $2 million in 2008. A lot of people have donated...It's very popular."

Respondents agreed that these activities have been successful. Although the recession had some financial impact, the program's flexible fundraising structure helped it to weather the economic storm. Establishing the TPI within the city's line-item budget, combined with engaging the philanthropic community, provided greater financial stability. This, along with the city's detailed planting plan, allowed New York to secure a supply chain of quality trees through long-term contracts with regional nurseries.

Still, respondents noted difficulties and identified opportunities for further improvement. The public budget shortfall and recessionary slowdown in nonprofit fundraising pushed the city's parks department into the fundraising arena. An interviewee elaborated on the difficulties:

> There is some tension in the arena of fundraising because there is direction for [the Parks Department]…to raise some of the funds to fill in the gaps where programming needs to happen…There are a limited number of funders and the question is, how do we coordinate this with our nonprofit partner, especially as they are fundraising not only for MillionTreesNYC but for other programs as well.

Respondents reported efforts to resolve these tensions, reviving an earlier practice of biweekly meetings between the city and their nonprofit partner to discuss funding issues and joint "asks" to potential sponsors.

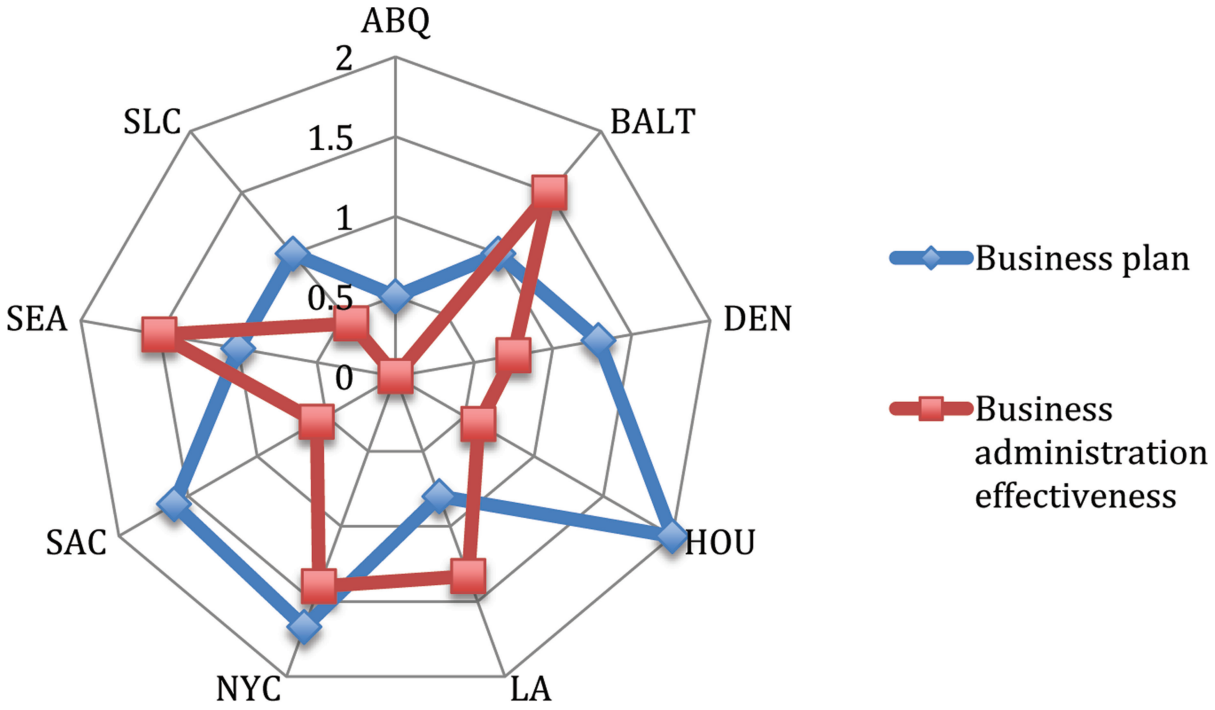

Figure 3. Perceived levels of business plan development and effectiveness.

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Houston interviewees perceived the greatest gap between business planning and effectiveness. The original business plan suggested a strong start for their TPI calling for the city to provide a third of the program's funding, with the remainder raised privately. While this formula held during the first year, it unraveled because of the recession and because TPI support was placed with the general fund rather than with a dedicated source.

Reductions in public funds made it difficult to raise private money once initial enthusiasm waned. A public sector respondent observed, "It would be better to have a dedicated source of funding rather than the general fund because if the general fund goes down then [the city] doesn't have match dollars for the program."

Short-term federal funds to the Texas Department of Transportation, continued nonprofit efforts, and a corporate-sponsored tree giveaway program have allowed the program to add to the urban forest, but respondents worried that, when these sources lag, the initiative will be seriously impaired.

Los Angeles's initiative began with financial planning that respondents described as being out-of-touch with real program costs. This situation, coupled with the recession, prompted reevaluation and new strategies. The revised approach replaced general fund support with fundraising that relies on grants, corporate donations, and in-kind contributions.

Considerable in-kind donations helped buoy the program, but this strategy is not without difficulties. As a nonprofit respondent observed, the program has "experienced a lot of people not wanting to fund the City directly….They do not think the money will be used efficiently. That has been a challenge…there have not been enough funds raised to support this work."

Despite these obstacles, stakeholders described the program's immediate financial situation as positive; however, they perceived long-term dangers, citing the City of Sacramento's experience, where overreliance on grant money to fund the TPI led to programmatic starts and stops, changes in key personnel, and a loss of momentum and partner participation.

Public Awareness Plans. TPI public awareness plans encompass outreach to different constituencies, reporting of program accomplishments, and disseminating of basic program information.

Baltimore interviewees reported the closest proximity between public awareness efforts and effectiveness. They described their TPI's outreach in terms of diverse, grassroots, neighborhood-based approaches, including community events, yard signs, and public advertisements at transit stops, on buses and street lanterns, and in local publications (Figure 4).

This "broad spectrum outreach," as a respondent labeled it, was necessary to get private landowners involved

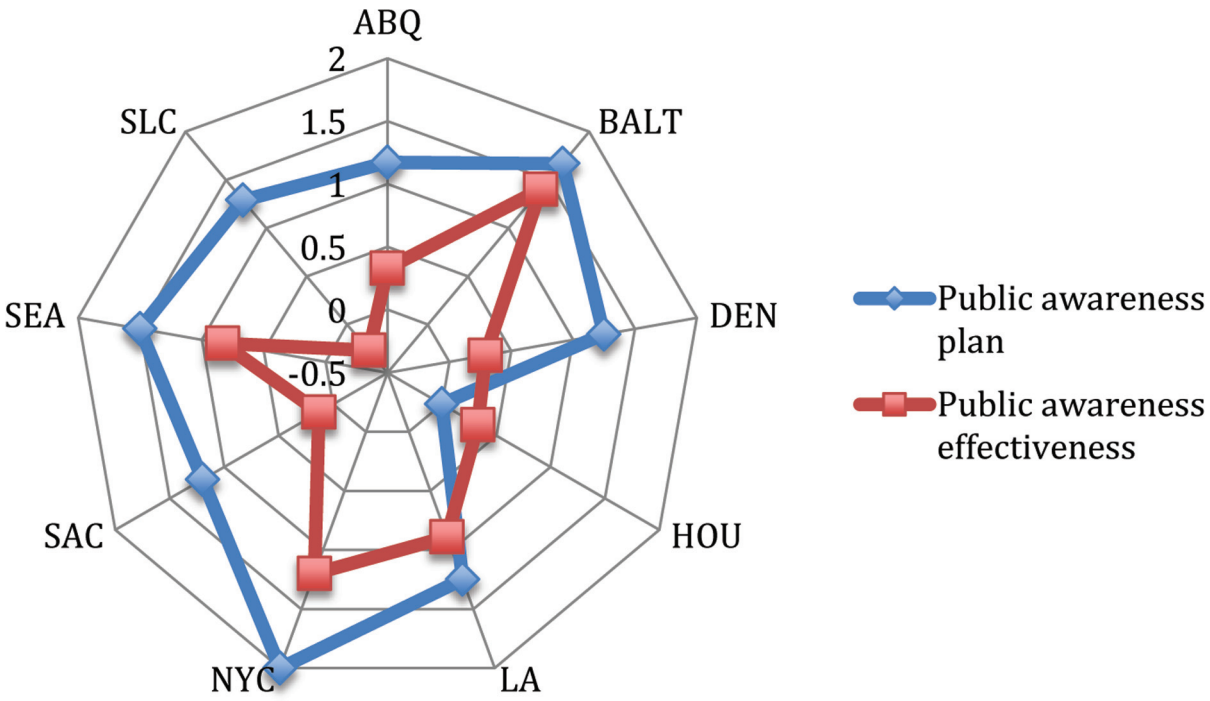

Figure 4. Perceived levels of public awareness plan development and effectiveness.

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because, as one interviewee noted, "A large percentage of planting spaces [for trees] are on private property."

In support of these efforts, Baltimore's TPI launched a door-to-door campaign in target neighborhoods to promote support for urban reforestation. An interviewee detailed the approach: "We trained people to go out into the neighborhoods with free literature; this was a successful way of reaching out to citizens and getting them involved and requesting trees." These contacts led to community networking that allowed "using them as a mouthpiece… going to neighborhood association meetings and identifying 'green' people who want to be involved."

Despite their enthusiasm with this approach, respondents felt that the city's limited resources deterred higher level investments in citywide media such as television and radio. Respondents expressed concern that this made citizen education incomplete, thus leaving many homeowners with misconceptions about the extent to which trees damage property and water utilities, generate excessive litter, and encourage criminal activities.

Salt Lake County interviewees perceived the greatest gap between public awareness planning and effectiveness. Interviewees recalled the initiative starting with energetic, diverse outreach components. Beginning with the mayor's and other public officials' active engagement in planting and public relations events, the program also harnessed a range of alternative media, including a blog, a Twitter site, and a webpage with links to authoritative references, photos, and videos.

After the launch, however, momentum flagged. While respondents felt outreach efforts were still reaching media and political representatives, there was little agreement that it had sustained public education and involvement. Respondents attributed this failure to sporadic upkeep of the website and inconsistent public relations efforts. Interviewees expressed concern about public tree-planting activities and tree-count numbers being out of date on the TPI website and other electronic postings. Respondents felt that the lack of ongoing communication impaired the initiative's ability to excite and educate a public whose support was uncertain. A nonprofit respondent from Houston colloquially described a similar situation in his own city: "The loss of enthusiasm after the initial press conference is normal but not letting it die down is critical. After that if you want to get people interested again it's like trying to light wet firewood."

Interviewees from Houston viewed their initiative as having a very low level of public awareness planning, but they rated the program's effectiveness in creating public awareness slightly higher. Respondents credit this success to early gains in public attention through the program's initial launch and its sporadic yet ongoing tree-planting activities.

According to Houston's TPI stakeholders, future outreach was hampered by lack of follow through, launching the program too late in the mayor's term, and linking the initiative too closely to the mayor's reelection. The vacuum resulting from the mayor's departure and the recession reduced the initiative's outreach planning to a piecemeal effort. A nonprofit participant summed up this perspective: "The city does it ad hoc. Each group does a good job of getting out the news on [tree-planting] events. But since there is no plan there is no overall education and outreach program."

Albuquerque interviewees reported similar limitations: The mayor's strict control of outreach, combined with his subsequent defeat, undermined the initiative's momentum.

Discussion

Conventional wisdom long considered beautification urban forests' primary function. Recent research transcended this perspective, placing urban forests in the context of GI and quantifying the public value they generate. Now, TPI in major cities across the United States are creating opportunities for planners to gain experience in developing and implementing GI on a metropolitan scale. Interviews with stakeholders revealed that cities are using this opportunity to reorient tree planting around GI goals, and to incorporate a broad scope of planning elements to support their efforts. However, stakeholder perspectives on the varying success rates of these initiatives illustrate the vulnerabilities of attempts to plan and implement large-scale, urban GI.

TPI Program Goals

While urban forests in many cities have declined in recent decades, respondents clearly regarded the goals of their city's TPI more broadly than tree replacement or civic beautification. For many, TPI represent a conscious effort to engage GI to address ecological issues and deliver public goods. In adopting this view, stakeholders are reconnecting with the perspective of earlier, influential planners such as Olmsted, Howard, and Wright, that metropolitan-scale greening (i.e., parks, street trees, and regional green belts), should be considered part of a city's fundamental infrastructure.

By adopting this perspective, stakeholders are also connecting metropolitan TPI with contemporary definitions of GI's ecological and social benefits. While not contending, as Elizur Wright did in 1893, that "forests alone can save

great cities" (Rawson, 2010, p. 62), present-day TPI stakeholders join current GI advocates in envisioning an important role for urban forests: increasing community sustainability, improving water and air quality, moderating climate, and fostering a new sense of civic environmentalism.

TPI Planning Scope

Respondents also described gaining experience with the scope of planning necessary to support their city's TPI. They offered a critical assessment of this experience, indicating a complex interplay among data, funding structures, institutionalization, and cultural norms that defined the approach, strengths, and vulnerabilities of their city's TPI.

Data-Driven Planning

Interviewees repeatedly stressed the importance of combining data-driven planning with diverse, institutionalized funding sources. New York City respondents described their TPI as being based on layers of social and ecological information and nested in the city's sustainability master plan. This enabled them to develop a phased, long-term tree-planting plan. Such a detailed planting plan enabled the city to develop a sound business plan for their TPI by diversifying funding sources, institutionalizing tree acquisition in the capital budget, and establishing long-term contracts and quality control with nurseries. These factors have given New York's TPI control over its supply chain and stability in recessionary times. Interviewees noted, however, that leaving stewardship in the general fund, where it is reliant on short-term private contracts and volunteer efforts, made this investment vulnerable.

The absence of in-depth data collection and program funding forced other TPI in this study to explore public–private partnerships in order to maintain momentum. Lacking detailed, comprehensive planting plans and significant public sector support, respondents in Los Angeles and Baltimore joined advocates of other tree-planting efforts in underscoring the importance of rescaling efforts to the neighborhood level and building the public into planting and stewardship plans (Shoup, 2009). For example, while participants deemed Los Angeles's initial, citywide planting plan unrealistic, and Baltimore's remained largely underdeveloped, stakeholders in both cities were able to use neighborhood-level data to target low-canopy areas. Los Angeles developed service contracts with local nonprofits to provide planting and initial care, while Baltimore used intensive neighborhood outreach to encourage homeowners to accept trees. Still, this grassroots approach is not a panacea. As noted by interviewees in these and other metropolitan areas, including Salt Lake County, Sacramento, Albuquerque, and Houston, variability in corporate funding and reliance on nonprofits, citizen's groups, and individuals cannot replace the full commitment of a city's budget and workforce in supporting citywide infrastructure.

These tensions reflect larger divisions within public–private partnerships. While such partnerships have long been a part of city government, researchers argue that their use has increased markedly over the past several decades. They credit this to opportunities to pool organizational strengths and resources, to increase participation and strengthen civil society, to overcome contractual obstacles, and to expand value-driven rationales to public policy implementation (Besley & Ghatak, 1999; Osborne, 2000; Stoker, 1997; Wettenhall, 2003). Researchers argue that this shift is also necessitated by structural changes in municipal finance that have weakened cities' ability to invest in infrastructure and provide public goods (Bovaird, 2004; Hackworth, 2007; Stoker, 1997).

The popularity and scope of public–private partnerships has prompted researchers and policymakers to investigate their overall value. Their calls for assessment extend to public–private infrastructure projects where researchers have found "contradictory results regarding their effectiveness" (Hodge & Greve, 2007, p. 545; see also Grimsey & Lewis, 2002). This conclusion reflects the experience of several TPI. While nonprofits and the private sector have participated in TPI implementation, and corporate contributions provided some support, underinvestment in mobilizing nonprofit and volunteer resources and the uncertainty of private financial commitments have prevented TPI from fully relying on these relationships. The result has left long-term stewardship of the urban forest in question.

Public Sector Commitment

The importance of sustained public sector commitment is underscored by the experience of respondents in Houston, Albuquerque, Sacramento, and Salt Lake County. These cities launched TPI to considerable fanfare; however, interviewees reported that failing to institutionalize business and outreach plans left the initiatives drifting. The absence of dedicated funding in Salt Lake County, combined with lack of outreach, has made progress difficult in a civic culture that, respondents noted, does not yet prioritize urban trees. Houston and Albuquerque's situations were similar. Relying on the general fund, corporate donations, and the mayor's political viability made TPI funding vulnerable. Although cultural stewardship norms were built into short-term private sector contracts in Houston, reliance on boom times and charismatic politicians rather than institutionalized plans made long-term investment in these cities' GI uncertain.

Seattle offered an interesting cultural counterpoint. While the city's tree-planting plan suggests rather than prescribes, interviewees reported that concern for the urban forest was built into the mission of the city's agencies and nonprofits. Thus, although it lacks the coordination, funding, and mandate of New York's TPI, Seattle's effort is still close to meeting its planting goals.

Financing GI

Despite stakeholders' perceptions that their respective TPI represent important steps in metropolitan GI, the programs largely use cost-based budgeting and rely on city general funds, grants, and donations for support. In this regard, they reflect the experience of most urban forestry programs in the United States (APWA, 2007b; McPherson, Simpson, Peper, Maco, & Xiao, 2005). This approach to financing TPI, while common, belies the fact that, despite stakeholder perception and advocacy, large-scale TPI are not fully considered part of metropolitan regions' fundamental infrastructure (APWA, 2006).

However, as urban forests' benefits become more widely understood, federal, state, and local funding tools conventionally reserved for traditional infrastructure are becoming increasingly available. At the federal level, the 1990 Food, Agriculture, Conservation, and Trade Act (the Farm Bill), and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) made initial steps toward recognizing urban forestry's role as a component of the nation's infrastructure (Burban & Andresen, 1994). At the local level, a few governments are experimenting with special assessments, special tax districts, and utility surcharges as mechanisms to create dedicated urban forestry funding (APWA, 2007b). Opportunities to deploy this latter mechanism may increase, as urban forests' contribution to public goods becomes more fully understood (A. Hillman, personal communication, July 20, 2011).

As stated above, municipal forests improve water and air quality, public safety, energy conservation, and risk and disaster management. As such, they are an investment worth hundreds of millions of dollars in avoided costs. Recognizing this, some communities have begun to explore treating urban forests as public utilities by incorporating their financing into local utility bills (N. Bjorklund, personal communication, July 19, 2011). Extending this logic could potentially result in monetizing and bonding urban forests' revenue streams as the basis for greater investments in green infrastructure.

Best Practices

While cities' environmental and social variability preclude generalizing best practices in GI design, respondents' experiences offer a general outline for planning GI at the metropolitan scale. Acknowledging urban forests as being on par with traditional gray infrastructure is central. Compiling detailed data about the distribution, health, and contribution of a city's urban forest; placing tree acquisition and stewardship in the capital budget; and maintaining a sustained public outreach and education campaign are fundamental to this status.

Absent direct municipal implementation, this study suggests that contracting initial planting and stewardship responsibilities through private or nonprofit and community actors can provide short-term advancement and protection of GI investments. Municipalities can oversee performance and quality; however, this still leaves longer term stewardship unaddressed. Nonprofits and volunteers can provide some tree-planting and long-term stewardship capacity, but without financial support they cannot match serious engagement by the public sector. Relying on the grassroots requires investment and, in this wired age, a commitment to maintaining alternative media (websites, blogs, Twitter, etc.) to sustain enthusiasm and participation. Without such support and commitment, grassroots efforts are insufficient. If supported, however, community-level engagement could become an important factor in implementing planting plans and protecting GI investments, budget priority, and interest despite changes in administration.

Last, while well-developed planting, stewardship, business, and outreach plans are the ideal, fostering a robust community of support in both the general public and in municipal agencies is critical. It is important for these constituencies to view the urban forest (and GI in general) as a civic norm in order to secure the long-term vision and investment required to achieve this new direction in urban infrastructure (Lieberknecht, 2009).

Conclusion

These cities' efforts to establish significant urban forestry initiatives reflect new levels of engagement in metropolitan GI and suggest further opportunities for national and international research. The nine TPI considered in this article were launched without federal direction. However, the size, geographic distribution, and diversity of these initiatives suggest opportunities for developing federal policy instruments that could drive national urban reforestation as a significant metropolitan GI strategy. These efforts could extend federal policies like the Environmental Protection Agency's Clean Water Act Phase II municipal storm water permitting regulations, enabling

cities to include urban forestry best management practices in their municipal storm water management plans (Schwab, 2009). Research examining cost-sharing, regulatory, and policy mechanisms used by prior federal metropolitan clean air and water programs could help identify means to increase national urban forest restoration and expansion.

Research on large-scale, bottom-up efforts could also contribute to the emerging field of international GI research. New focus by researchers and institutions as diverse as the World Bank, Worldwatch Institute, and the Megacities project have situated metropolitan centers as important actors in the transition to a sustainable future (Konijnendijk, Sadio, Randrup, & Schipperijn, 2003; Perlman & O'Meara Sheehan, 2007; World Bank, 2009; Worldwatch, 2007). The bottom-up nature of GI efforts in U.S. cities, combining grassroots, municipal, and corporate institutions, can provide precedent for similar types of collaborations outside of North America. While U.S. efforts may be better supported, several of the study cities engaged (with little funding) creative, grassroots strategies to advance their cities' TPI. These examples can add to the emerging international GI discussion (Konijnendijk, Sadio, et al., 2003). As the number and scale of these types of initiatives grow, such cross-comparisons may become increasingly valuable for joint research and collaboration.

However, coordinated federal and international efforts to plan and implement metropolitan GI are still in their infancy. In the meantime, initial efforts such as those described in this study must serve as the training ground for planning as it seeks out strategies to foster the living city.

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