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Mainstreaming urban ecosystem services: A national survey of municipal foresters

Robert F. Young

Abstract Researchers and advocates are calling for ecosystem services management to advance from theory to implementation. To do so, they argue, requires two things: information on the science and practice ecosystem services management to be more widely developed and distributed, and support for ecosystem services management be incorporated into decision-making. These changes require adding to urban ecology an understanding of the political and information relationships supporting work in this field. To gain insight into these relationships I surveyed the national membership of the Society for Municipal Arborists about their efforts in managing municipal green space to produce ecosystem services. A significant percentage of respondents reported their organizations currently engaged in managing green space assets to produce ecosystem services and predicted such activities would increase over time. Foresters noted they relied on public and informal peer relationships as primary information sources in these efforts and reported little interface with private sector entities, viewing the latter, rather as most likely to constrain their efforts to enhance the production of ecosystem services. While foresters noted that they sought information from public and academic sources, the foresters themselves were less frequently sought out for their expertise. Respondents, however, foresaw becoming engaged in more reciprocal relationships around information exchange. The private sector's absence in these relationships suggests insufficient legal and regulatory structures necessary to support private engagement in the growing demand for urban ecosystem services. The broad base of local grassroots and public support, however, suggest the emergence of constituencies that could lay the basis for new coalitions to advance green infrastructure and its related ecosystem services into the mainstream of municipal resource management.

Keywords Green infrastructure · Ecosystem services · Political support · Information · Society of Municipal Arborists · Urban forest · Implementation

Introduction

Researchers are calling for ecosystem services management to come of age. While current study on ecosystem services valuation is built upon a long tradition of inquiry, researchers

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and activists are calling for such knowledge to move from theory to implementation (Cowling, et al. 2008; Daily and Matson 2008; Kremen 2005; Mooney and Ehrlich 1997; Ruhl, et al. 2009; Schumacher, 1999). To do so, they argue, requires two important advancements. Information on the science and practice ecosystem services management must be more widely developed and distributed, and support for ecosystem services management must be incorporated into individual, corporate, and government decision-making (Cork et al. 2001; Daily et al. 2009; Young and McPherson 2013).

To accomplish these goals, researchers contend, ecosystem services practitioners must develop more robust information flows and political support among a broad spectrum of social actors. This requirement is particularly pertinent to managing ecosystem services in urbanized settings where the frequency of environmental disturbance, density of demand, and potential number of stakeholders are very high (Barthel 2006; Bolund and Hunhammar 1999; Ernstson, et al. 2008).

In many cities, urban forests play a critical role in delivering public benefits through ecosystem services that lower public service costs and increase capital accumulation by mitigating water, climate, and air quality problems as well as improving quality of life and property values (APA 2009; Benedict and McMahon 2006; Daniels 2010; Hirsch 2008; Muldavin 2010; Nowak and Crane 2002). As such, urban forests are recognized as a fundamental component municipal green infrastructure (Amati and Taylor 2010; American Planning Association [APA] 2009; Konijnendijk 2010; Konijnendijk et al. 2005; Schilling and Logan 2008).

Gaining a detailed understanding of municipal foresters' perception of the sources of information and political support helping them manage urban forests for ecosystem services is important to bringing the production of these services into the mainstream of urban planning and implementation. This is especially the case as local actors, knowledge, and perspective are a vital, though, researchers assert, often overlooked and underutilized component of these relationships (Barthel 2006; Ernstson, et al. 2008; Olsson and Folke 2001). Local actors, in their roles as resource and information managers, political decision-makers, and place-based inhabitants are intimately engaged with both ecosystem services production and outcomes. While larger-scale social and ecological factors are always present in shaping ecosystem services, these factors must eventually be expressed in specific locations where their influence, along with more localized ones, are mediated and managed by local actors. Still, despite this pivotal role, researchers note, community representatives and values "in planning for conservation and environmental management…are rarely considered" (DeFilippis 2004; Kremen 2005; Raymond, et al. 2009)

To explore the perceptions of local actors concerning sources of information and political support for ecosystem services management I performed a national survey of the membership of the Society of Municipal Arborists (SMA). Through this study I sought to gain greater comprehension of the following questions: Do municipal foresters view their organizations as engaged in managing municipal green space to enhance the production of ecosystem services? If so, what sources of expertise (information) and encouragement (political support) do municipal foresters view as valuable in advancing this goal? I also sought to understand whether these relationships were reciprocal and how SMA members' perceived they might change over time.

In this paper I chose to focus on members' responses regarding ecosystem services related to water quality and energy and climate. I selected these elements for several reasons. Each is vital to the long-term success of cities and, unlike property values, are material rather than social outputs. In addition, they are critical contemporary issues fundamental to other important factors such as biodiversity and future urban development patterns.

Background

Researchers and public intellectuals are moving their discussion of global-scale, human-induced, ecological decline toward a systems perspective. This approach identifies "nature" as a complex production system providing vital life support services to society, reframes environmental and social disturbances in a broader, interconnected socio-ecological context, and acknowledges the complex and uncertain interplay of ecosystem interventions, impacts and outcomes (Millennium Ecosystem Assessment 2005; Costanza et al. 1997; Daily 1997).

This new perspective is being applied to urban systems as well. The unprecedented rise in urbanization and decline in ecological health has generated efforts to protect social and ecological capital (Heal et al. 2001; Pretty and Ward 2001; Dale and Sparkes 2008; Hawken 2007; Polanyi 1957). Reconceptualizing the city is an important component of this movement. In opposition to the modernist city presented by planners such as Daniel Burnham and Robert Moses and the current neoliberal city, researchers, activists, and public intellectuals are exploring the idea of cities as ecosystems (Botkin and Beveridge 1997; Caro 1974; Hackworth 2007; Newman and Jennings 2008; Smith 2006). In doing so they are taking the fields of urban ecology, planning, and landscape architecture back to roots planted over a century ago (Young 2009).

Important to the concept of cities as ecosystems are efforts to reconfigure the delivery of municipal services around green infrastructure. Researchers, activists, and public sector regulators define green infrastructure as including both ecologically and socially constructed green space that produce "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 and McMahon 2006, p. 1; Dunn 2010; Tzoulas et al. 2007). They label these outputs ecosystem services and propose green infrastructure as an alternative means of delivering these public goods in the new ecological or living city (Baskin 2008; Daily 1997; Young 2010; Young 2011).

Ecosystem services and the private sector

The public sector has taken the lead in initiating a number of large-scale, urban green infrastructure projects (McPherson et al. 2011; Young 2011; Young and McPherson 2013). Political limits to taxation, however, have proscribed public sector ability to invest in their more general implementation leading many researchers and policy makers to call for a broader private sector role. They argue that ecosystem services represents a significant opportunity for business while acknowledging the complex undertaking required to set up the necessary relationships and markets (Perrot-Maitre 2006; Gutman 2007).

Although there is an extensive literature endorsing private involvement in the provision of ecosystem services, the question of its efficiency relative to the public sector is still open as many researchers acknowledge that "markets so far appear to have failed to provide an efficient allocation of many ecosystem services" (Casey, et al. 2006; Kroeger and Casey 2007, p. 321; Gustafsson 1998).

The delivery of many ecosystem services occurs rather, outside traditionally defined markets. Even where established, markets for ecosystem services "are relatively new and often thin" (Kroeger and Casey 2007, p. 324). A central reason for the comparative weakness or absence of ecosystem service markets is the public goods aspect of many of such services (Brown et al., 2007). This non-exclusive aspect makes private appropriation of their value problematic. In addition, without readily accessible markets "many private sector firms are reluctant to pay for ecosystem services precisely because they believe that the public sector should do so" (Koellner 2010; Farley and Costanza 2010, p. 2063).

Since, "markets are embedded in a larger institutional context that both enables and restricts the behavior of participants" researchers and policy analysts identify government involvement as fundamental to creating private markets for most ecosystem services (Bromley 1997; Kroeger and Casey 2007, p. 321). However, the absence of structural supports such as generally accepted ecosystem service value assessments, property laws, and regulatory powers severely limit the current ability of the public sector to create an enforceable market. Indeed, again, given the public goods nature of many ecosystem services, researchers contend it is difficult to create such opportunities that do not tend toward privatization of the asset (Kraft, et al. 2008; Loomis, et al. 2000).

Addressing these social relationships is central to mainstreaming ecosystem services. Acquiring more detailed understanding of the flows of information and political support promoting ecosystems services management is fundamental to this goal. While literature on rural or hinterland ecosystem services dominates the discourse, addressing these issues in cities where sources of information and the number of social actors are potentially more extensive is important to bringing ecosystem services into the norm of urban and regional planning (Gutman 2007; Jenerette et al. 2006; McPherson 1997,).

Urban forests and municipal green infrastructure

Urban forests are a key component in the planning of municipal green infrastructure to produce ecosystem services. In the United States researchers estimate that "with an average tree cover of 33.4 %, metropolitan areas collectively support nearly one quarter of the nation's total tree canopy cover" (Dwyer et al. 2000, p. iii). In addition to street trees, researchers and public advocates define the urban forest as including "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 forest managers confirm this definition. As noted in Young (2010), SMA members report their organizations engaged in working with a broad range of municipal green space assets (see Table 1).

Knowledge, policy, and adaptive management

Green infrastructure (or greenstructure as it is referred to in Europe) employs "a multi-objective approach that uses ecology as a base" (Erikson 2006, p. 37). Adopting this

Table 1 Green space assets SMA members' organizations help manage (percentage of respondents)

Type of green space	Percentage of respondents
Street trees	87.7
Small "pocket" parks (under or equal to 3 acres each)	76.7
Grounds of public buildings	75.0
Large parks (over 3 acres each)	73.2
Natural areas	69.1
Utilities (rights of way, etc.)	39.1
Cemeteries	35.7
Other	24.4

approach brings its own challenges. While it has enabled researchers and policy advocates to better conceptualize urban ecosystem issues and dynamics; their scale, increasingly recognized interconnectivity, and uncertainty regarding outcomes requires increased information and policy coordination among decision makers and practitioners (Johnson 1999; McCain and Lee 1996; Norton 2005; USEPA 2007; Voloscuk 2002). As noted in the Millennium Ecosystem Assessment [MEA], "The context of decision-making about ecosystems is changing rapidly. The new challenge to decision-making is to make effective use of information and tools in this changing context in order to improve the decisions" (MEA 2005, p.5).

Researchers and practitioners propose adaptive ecosystem management as a means to address these challenges. Adaptive management recognizes the diversity of ecosystem elements and uncertainty in predicting future disturbances and outcomes. It emphasizes, therefore, reflexive management systems dependent upon robust information flows and responsive management support (The Resilience Alliance 2010; Pahl-Wostl 2007; Christensen, et al. 1996).

Researchers, however, have criticized adaptive management for insufficiently incorporating the political priorities and relationships necessary to support successful ecosystem management. As the US Forest Service has noted, "[a]daptive management is irreducibly sociopolitical in nature" (Stankey, et al. 2005, p.57). In response, researchers and advocates have called for adaptive management to be reframed as a social process, prioritizing institutions as well as science in its approach (The Resilience Alliance 2010; Lieberknecht 2009; Gregory et al. 2006).

Reconceptualizing cities as ecosystems, and researchers and advocates call to manage urban environments as such, places adaptive management in an institutionally rich environment. The heightened level of disturbance and density of institutions and information that distinguishes urban ecosystems both recommends adaptive management and emphasizes the importance of incorporating social relationships into its management strategies. Improving our understanding of the information and political patterns supporting municipal foresters' efforts to manage urban green space to enhance ecosystem services can provide insight into how to better advance the production of these services in urban settings.

Understanding the structure of information and decision making flows is critical to addressing this challenge. Early communication models posited these flows as unidirectional, moving either from mass or elite media sources and opinion makers to passive adopters (Croteau and Hoynes 1997; Katz and Lazarsfeld 1955). Researchers have criticized this model as too simplistic, lacking detail in describing the complicated, multidirectional reality inherent in information exchange and policy adoption (Castells and Cardoso 2005; Rogers 2003; Primmer and Wolf 2009).

While research confirms the importance of media and boundary-spanning individuals in the diffusion of innovations and policies, understanding the diversity of sources and agents and their relative importance in regard to particular policies and management practices is critical (Just et al. 2006; Ritter and Gemünden 2003; Troldahl 2001). In addition, conceptualizing the possibility of reciprocal flows of information between sources, agents, and practitioners is also vital. This is particularly important in efforts to mainstream urban ecosystem services policies and management as "urban environments present a key contemporary context in which different forms of knowledge intersect with fragmented policy arenas, often in complex and contentious ways" (Owens et al. 2006, p.632).

Many researchers have noted the difficulties in linking scientific research with policy initiatives when "neither the academic [n]or the political has a particularly well-articulated sense of the other's agendas, practices and discourses and still less of the possibilities for creating productive conjunctions." (Jasanoff 1990, p. 394). Others have noted the tremendous potential environmental knowledge in the "information age" offers for the transformation of policy and practice (Demeritt and Lees 2005; Mol 2006). However, as Owens, et al.

note, "if there is to be a meaningful new contract between science and society, we need to move on from simplistic concepts of knowledge transfer to more nuanced and sophisticated understandings." (2006, p. 641)

Research questions

To gain this understanding I ask the following question:

Do municipal foresters view their organizations as engaged in the production of ecosystem services? What sources of information and political backing do municipal foresters identify as supporting or obstructing their organizations' efforts to enhance the production of ecosystem services?

In answering these questions it was important to establish the extent to which municipal foresters rated their individual organizations' present and future engagement in producing ecosystem services. With this established, I wanted to learn specifically who, in terms of agencies, organizations, or constituencies provides information and political support that assist municipal foresters' organizations manage municipal green space to produce ecosystem services. I was further interested in who they feel obstructs their organizations' efforts to achieve this goal and their expectation of who will support or obstruct it in the future.

Additionally, recognizing that information flows are not solely linear I was interested in how often a range of agencies, organizations, or constituencies sought their organizations' expertise in enhancing environmental quality.

Methodology

To answer these questions I performed, in cooperation with the Society of Municipal Arborists (SMA), a survey of North American members of the SMA that asked:

- What is the range of municipal green space managed by SMA members' organizations?
- How important, in their management of these assets, do SMA members' organizations rate the production of ecosystem services over time?
- What specific sources of information and political support do their organizations perceive as important in encouraging or constraining their management of these assets to enhance ecosystem services?

Selection of survey population

As noted above, researchers argue that local actors hold valuable local ecological knowledge but are "often…a neglected group when analyzing natural-resource management systems" (Barthel 2006, p. 313). These groups often engage management practices influenced by both formal and informal local knowledge and institutions that can result in low-cost solutions to environmental challenges (Barthel 2006; Johannes 1998; Olsson and Folke 2001).

I chose municipal foresters to be the survey population as they represent a nation-wide community of local practitioners in the management of municipal green space assets. I selected the SMA membership as the survey population as the SMA is the largest professional organization representing municipal foresters in the United States (Society of Municipal Arborists 2010). Founded in 1964, SMA members also include consultants, commercial firms, and citizens who "actively practice or support some facet of municipal forestry".

Predominantly based in North America, the SMA membership is a professional affiliate of the International Society of Arboriculture. As such it is the leading professional organization of municipal foresters in North America. The SMA presents its mission as: "Leading the world in building the confidence, competence, and camaraderie of the family of professionals who create and sustain community forests" (SMA 2010). I surveyed the members of the SMA to gain insight into the sources of information and political support these members felt influenced their organizations' management of municipal green space to produce ecosystem services.

Definition of terms

Municipal foresters

Researchers and advocates use a number of terms to define managers of urban forests and associated green spaces (Konijnendijk et al. 2006). Historically and in the present forestry professionals managing municipal green space assets have been named: city forester, town forester, shade tree commissioner, tree warden, city arborist, municipal arborist, forestry consultant, community forester, and municipal forester (Ricard 2005; Harris et al. 2004; Miller 1997; Jorgensen 1986; Kinney 1972). For this paper I selected "municipal forester" to represent this population; "municipal" because the survey population members (SMA members) has self-identified an interest in urban green space management at the municipal-level, and "forester" in recognition of the historical and expanding role of urban forestry professionals and advocates beyond "single tree" management in the supervision of these assets. I use the term municipal forester and SMA member interchangeably in this paper.

Municipal forester's or SMA member's organization

I use "organization" in this paper to refer to the immediate department or agency to which the respondents report. It does not, in general, refer to the Society of Municipal Arborists itself except where specifically noted.

Municipal green space and ecosystem services

Throughout this study I define municipal or urban green space as publicly managed natural resource assets in a city or town including street trees, parks, "natural areas", cemeteries, utility rights-of-way, and the grounds of public buildings (Swanwick et al. 2003; Randrup et al. 2005; Konijnendijk et al. 2007). Not included in this study (although still falling within the definition of urban green space) are privately owned land such as individual residences, private parks, corporate campuses, and commercial and industrial areas.

Using categories identified in the Millennium Assessment (2005) I defined ecosystem services as functions natural assets provide including:

- *provisioning services*: (e.g. fuel and materials) and
- *regulating services*: (e.g. carbon sequestration, climate regulation, and water quality management)

For the survey I drew from the categories provided in the Millennium Ecosystem Assessment. In particular I surveyed SMA members' organizations' engagement in specific actions to produce particular ecosystem services such as water and air quality, energy and

climate, and biodiversity. As noted above, for this paper I focus on SMA members' organizations' actions affecting:

Energy and climate through:

- reducing urban heat island effect,
- sequestering carbon,
- providing renewable fuel and materials and

Water quality, through:

- reducing run off and flooding,
- reducing water born pollutants

Study execution and response rate

The SMA directors approved the study and the on-line survey was emailed to the membership and announced on the SMA web site. Outreach for the survey included two pre-survey notifications and two reminder notices from the SMA executive director emailed prior to and following the survey's distribution to the SMA membership (Dillman 2007).

The survey instrument contained eight sections. The first asked municipal foresters about the portfolio of green space assets managed by their organizations. This section also surveyed municipal foresters' perceptions of their organizations' present and past goals regarding environmental management and natural resource conservation of these assets. The following three sections of the survey prompted municipal foresters to rate the importance to their organization of several municipal green space management actions related to energy and climate, and water resources. The fifth section explored municipal foresters' perceptions regarding their organizations' present management of municipal green space to produce ecosystem services. The next section asked respondents their perceptions of present sources of information, support, or constraint of their organizations' management of municipal green space for production of ecosystem services. The last two sections of the survey asked respondents their expectations of the extent, in the future, their department would be engaged in managing municipal green space to produce ecosystem services and for the future sources of support or constraint of such actions.

This survey of SMA members received a 51 % response rate (599 respondents out of a possible 1,175). I used the data to identify respondents' perception of the importance of a range of objectives, specific methods, information sources, and constituency support to their organizations' work both currently and over time.

Results

Implementation: green space portfolio and management

Survey respondents indicated being engaged in managing a considerable range of green space assets (see Table 1 above). They rated their organization's current involvement in managing these assets to enhance ecosystem services production related to energy and water such as improved water quality, flood control and energy conservation, and climate change mitigation.

Nearly three quarters of respondents indicated their organization was moderately to very engaged in managing green space assets to produce ecosystem services with over a third identifying their organization as very engaged (see Table 2).

Table 2 SMA organizations' current level of engagement in managing green space to produce ecosystem services (percent respondents)

Current level of engagement	Percentage of respondents
Not at all	3.1
Slightly	24.2
Moderately	35.8
Very	36.9

In addition to understanding level of engagement I also wanted to establish the importance of specific ecosystem service outputs to SMA members' organizations in managing these assets. Approximately seventy five percent of respondents noted that energy and climate management, and enhancing water quality were moderately to very important management objectives for their organizations (see Table 3).

Lastly, in addition to understanding the current extent to which municipal foresters viewed their organizations as managing municipal green space to enhance ecosystem service production, I also wanted to understand their view of the trajectory of this objective. Approximately half of respondents noted that the importance of implementing ecosystem service production had increased over the past five years (see table 4).

Sources of information and political support

The first part of this survey assessed respondents' portfolio of green space assets and explored their view of the importance, trajectory, and specific objectives of their organizations' management of these assets to enhance ecosystem services. The second part of the survey explored the social processes, i.e. information flows and political support, they felt enabled their organizations to better pursue the production of ecosystem services.

Information

To explore these social processes I asked respondents to rate the importance of different sources of information relevant to their organizations' efforts to enhance the production of specific ecosystem services. I identified 5 categories of civic actors and 13 potential sub-groups (see Table 5).

Approximately a third of respondents rated the state and local governments as well as university scientists and SMA member's colleagues as very important sources of information in assisting their organizations' actions to enhance ecosystem services related to energy and climate. Developers, vendors, consultants, and non-profits were rated as relatively poor sources of information for these purposes (see Fig. 1).

In assisting their organizations' actions to produce ecosystem services related to water quality, the highest percentage of respondents rated federal, state and local governments as

Table 3 Importance of specific ecosystem service objectives in SMA organizations' management of municipal green space (percent respondents)

Ecosystem service objective	Importance			
	Not	Slightly	Moderately	Very
Energy and climate management	6.0	18.5	34.8	40.7
Enhance water quality	7.1	17.4	32.2	43.3

Table 4 Change, over the past 5 years, in the importance to SMA members' organizations of specific ecosystem service management objectives (percent respondents)

Ecosystem service management objectives	Importance		
	Decreased	Same	Increased
Energy and climate management	3.2	47.0	49.8
Water quality management	2.5	45.9	51.7

very important sources of information while rating developers, vendors, and non-profits least important (see Fig. 2).

Reciprocity

Robust relationships are typified by reciprocal information flows. Therefore, in addition to asking SMA members to rate the importance of information sources assisting their organizations' actions to enhance ecosystem services, I also asked them to identify how often others sought information from their organization about how to enhance these services.

Respondents reported individual residents as most frequently seeking information from their organizations and identified local government, colleagues, and neighborhood groups as the next most likely (see Table 6).

Political support

In addition to tracking the importance of various sources of information to SMA members' organizations, I also wanted to understand how SMA members rated sources of political support and obstruction in relation to their organizations' efforts to enhance the production of ecosystem services.

I was also interested in understanding such influence in terms of current and future support (or constraint) of SMA members' organizations' efforts to manage for ecosystem services. In response to queries about who supports, remains neutral, or tries to hold back their ecosystem services management efforts respondents described the greatest support as flowing from their professional association (the SMA), colleagues, residents, local government, and non-profits; notable support from university scientists and state and county government, and active resistance to their efforts from developers (see Fig. 3).

In addition, respondents described an increasingly robust network of support for their organizations' future management of municipal green space to produce ecosystem services. Local governments and colleagues were seen by over eighty percent of respondents as continued leading advocates for this type of work. Almost half thought the federal

Table 5 Civic actors by sector

Public	Academic	Private	Community of Practice	Grassroots
Federal	Faculty	Consultants	SMA	Neighborhood groups
State		Developers	Colleagues	Residents
County		Vendors		Non-profits
Local				

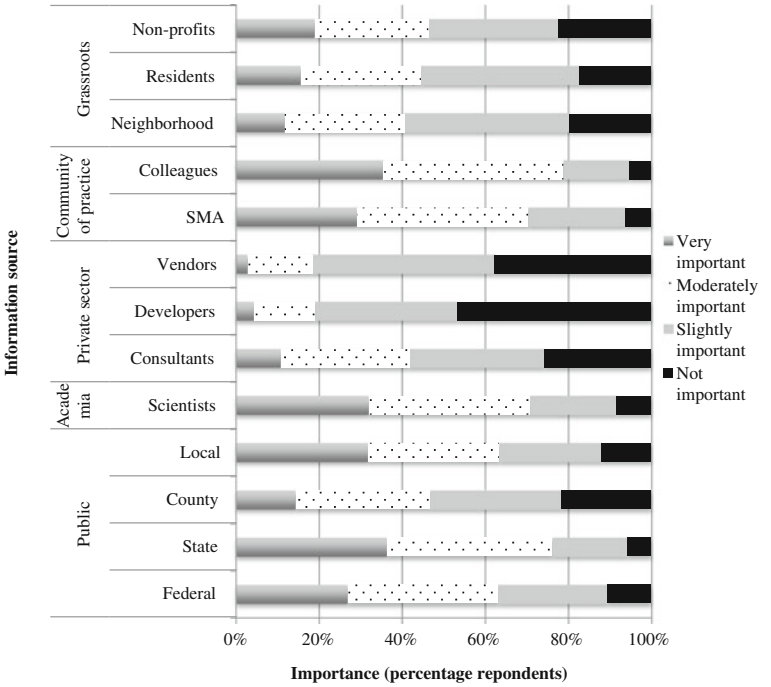

Fig. 1 Rating of information sources supporting production of ecosystem services related to energy and climate

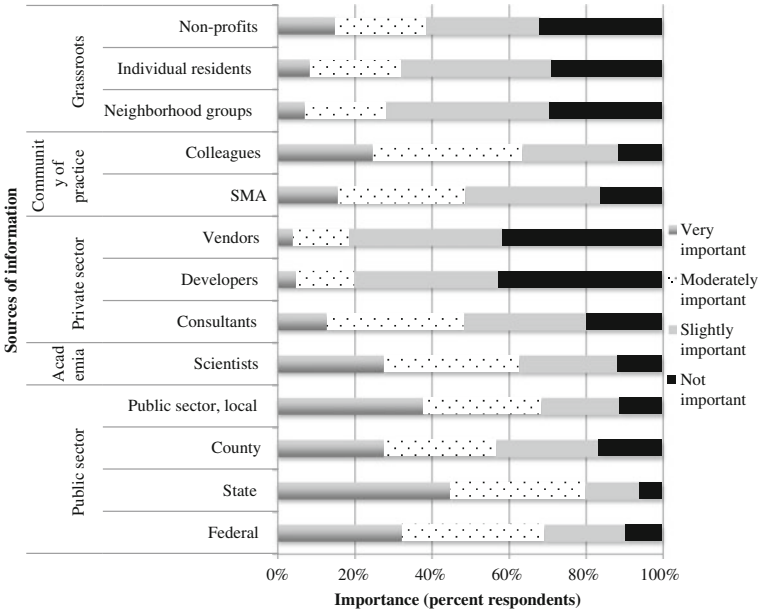

Fig. 2 Rating of information sources supporting production of ecosystem services related to water quality

Table 6 Frequency information sought from SMA organizations producing ecosystem services (percentage of respondents)

Source of queries	Once a month	Once a year	Once every five years	Never
Federal agencies	6.1	22.5	11.4	60.3
State agencies	19.8	34.3	8.5	37.4
County agencies	27.1	29.2	6.7	37
Local government	66.5	19.5	3	11
University scientists	11.8	27.7	11.8	48.7
Private consultants	31.4	24.8	7.4	36.3
Private developers	42.8	18.3	7.2	31.7
Private vendors	13.1	19.1	5.8	61.9
Society of Municipal Arborists (SMA)	9.1	27.9	7.6	55.4
Colleagues	59.8	23.3	2.4	14.5
Neighborhood Groups	54.9	26.4	3.4	15.3
Residents	74.7	13.7	2.8	8.8
Non-Profit organizations	34.9	30	4.6	30.6

government likely to remain neutral on the issue while nearly a third continued to identify developers as likely to constrain their organizations' actions to advance the production of ecosystem services (see Fig. 4).

Discussion

Researchers and advocates contend that management for the production of ecosystem services needs to transition from theory to widespread implementation. To make an important contribution to natural resource conservation and the provision of public goods, they argue, information on the science and practice ecosystem services management must be more widely developed and disseminated, and interest in ecosystem services management must translate into political support from a broad range of social actors (Cork et al. 2001;

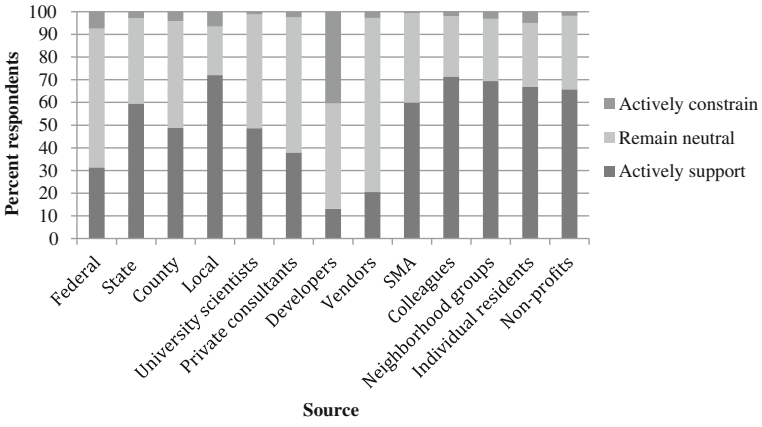

Fig. 3 SMA members' perception of current support for their organizations' management of green space to enhance ecosystem services (percent respondents)

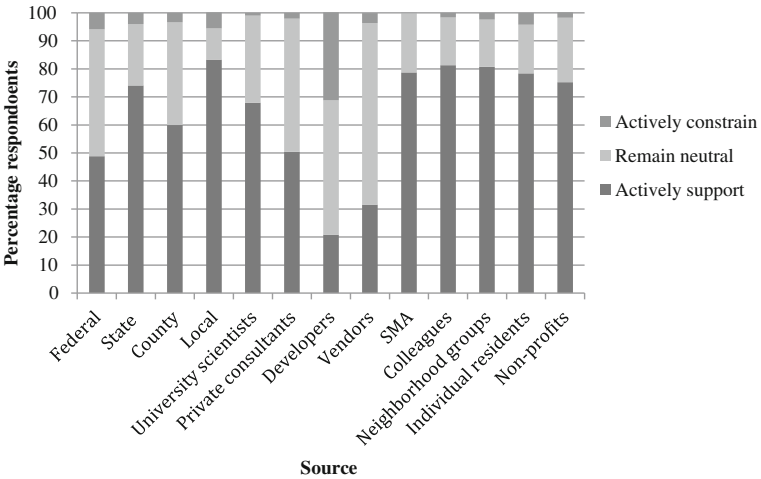

Fig. 4 SMA members' projection of future support for their organizations' management of green space to enhance ecosystem services (percent respondents)

Daily et al. 2009; WRI 2012; Young and McPherson 2013). "Without these advances," Gretchen Daily and her co-authors submit, "the value of nature will remain little more than an interesting idea, represented in scattered, local, and idiosyncratic efforts." (Daily et al. 2009, pp. 22).

Implementation

This call for ecosystem services to move from theory to practice is valuable. It presses for ecosystem services to become a normative component of natural resource management not only in rural and hinterland regions but in metropolitan areas as well (Daily and Matson 2008; Ervin et al. 2012; Loomis et al. 2000). The urgency of this call, however, overlooks the possibility that managing for ecosystem services at the local level could be more widespread than previously acknowledged.

As the above data show, municipal foresters view themselves already widely engaged in managing a broad range of natural assets to produce ecosystem services. Over three quarters of the survey's respondents deem it to be moderately to very important to their organizations' objectives and over a third of respondents report it to be very important. Municipal foresters have also detailed how their organizations are implementing this objective (Young 2010). The range of green infrastructure assets, the breadth of interest, and the current engagement and trajectory of SMA members' organizations in managing these assets to produce a variety of ecosystem services indicates they are involved in more than scattered, local, idiosyncratic efforts but are important actors in mainstreaming ecosystem services at the municipal level. The survey responses further reflect that SMA members see their organizations as holding the potential to greatly expand that role.

Information

Understanding the information sources currently supporting municipal foresters' engagement in the production of ecosystem services is important to capturing this potential. In addition, information flows encouraging and harnessing such activity are central to the further development and dissemination of ecosystem services in general (USEPA, 2009).

Despite this critical role, sources of ecosystem services information which practitioners regard as valuable appears to be diffuse. Survey respondents identified no single source of information as dominant; in fact no individual information source was selected by even half of the respondents as very important to their actions. Instead, the data reflected a diversity of sources making up the information portfolio that respondents found useful in supporting their efforts to enhance the production of ecosystem services.

This discrepancy reflects the on-going issue of connecting scientific research and public policy. Closing this divide will require increased attention to developing reciprocal research agendas and institutionalizing information exchange that allows for the effective organization and use of information on ecosystem services management. While research and policy efforts on ecosystem services are growing, scientists and policy makers have often found such efforts overly general or presented through a variety of locally-relevant scales and classification systems making both specific and broader application and analysis difficult (de Groot et al., 2002; Layke et al. 2010). To address this discrepancy, researchers maintain the necessity of learning from existing programs through place-based, long-term, interdisciplinary research that can build toward institutionalizing ecosystem valuation and legal and regulatory powers (Carpenter et al., 2009).

Municipal foresters represent a community of practitioners which views itself as significantly engaged in managing urban natural assets for ecosystem services. As such, they provide a nation-wide, locally-based network of existing programs which can serve as a laboratory for the assessment of ecosystem services interventions. Their high ranking of more localized public or collegial information sources underscores the opportunity and the need to place such research in the context of place and communities of practice. Local efforts to manage natural resources for ecosystem production are often overlooked, however researchers and policy makers can take advantage of local and informal networks and knowledge developed by municipal foresters to construct more general frameworks for analysis and implementation of ecosystem services management (Carpenter et al., 2009; Goldman et al. 2008).

Taking advantage of these networks would require a much greater degree of reciprocity than currently exists. While municipal foresters draw information from a variety of sources, they themselves are rarely seen as sources of important information on ecosystem services management. Over sixty percent of respondents reported never having been contacted by anyone from the federal government seeking information on municipal foresters' ecosystem services management efforts. Strikingly, nearly half stated university researchers had never sought them out on this account either. The absence of a reciprocal relationship with scientists is troubling as municipal foresters' actions and the knowledge and capacity they generate are vital to advancing the science of ecosystem services. As Carpenter, et al. (2009) note: "Progress in sustainability science does not resemble the usual paths of scientific inquiry, where action lies outside the domain of research. Instead, scientific inquiry and practical application are commingled" (Carpenter, et al. p. 1,305).

When looking at information flows as a whole, local government and colleagues best approximate the ideal of a reciprocal relationship of information exchange with SMA members. This may contribute to the value SMA members place on information from these sources. Federal agencies, university scientists, consultants, and vendors might enhance their profile as well if they took efforts to increase reciprocity in their information flows with SMA members.

While municipal foresters viewed local governments and colleagues as valuable sources, the private sector was deemed of little to moderate importance in supplying information regarding ecosystem services. Low levels of interest in private sector expertise as a significant source of ecosystem services information for municipal foresters suggests several possibilities. First, it could reflect the private sector's indifference toward a field with

significant business potential. Second, it may suggest the underdevelopment of the type of public regulatory, legal, and incentive structures necessary to induce private sector investment in urban ecosystem services markets. Third, as noted above, the non-exclusive, public goods aspect of many types of ecosystem services may make them more amenable to public sector development and support than private sector investment and profit.

While these questions invite further research what is clear is the increasing opportunity for significant investments in metropolitan green infrastructure. The American Society of Civil Engineers project immense capital expenditures will be made in the near-term to support infrastructure repair and expansion both within the United States and internationally. They estimate the investment necessary to maintain and extend infrastructure services in the United States at $6.5 trillion. This is eclipsed by Latin America's estimate of $7.8 trillion which is in turn surpassed by Europe's bill of $9.15 trillion and Asia's requirement of nearly twice that of $16 trillion. These expenditures contribute to a combined, global total of $41 trillion in required infrastructure investment over the next 20 years (APWA, 2006; Donaghy, 2013).

Many communities such as Philadelphia, New York, and Los Angeles are reassessing their ability to address this shortfall without engaging green infrastructure as a significant support strategy. Initiatives such as Philadelphia's Green City, Clean Waters Program, New York's Green Infrastructure Plan and the City of Los Angeles's Green Infrastructure Program are examples of a change in course in infrastructure investments toward ecosystem services (EnvironmentLA 2012; New York City Mayor's Office 2011; Philadelphia Water Department 2012). SMA members' assessment of the private sector's absence as a valuable source of ecosystem services information infers that private consultants, developers, and vendors may be foregoing a significant business opportunity as more municipalities invest in green infrastructure to provide public services.

Political Support

Information on ecosystem services management is important both for its delivery of technical assistance as well as for building the cultural context necessary for successful political support (Hahn et al. 2008). As Manuel Castells notes, "the structure and dynamics of socialized communication is essential in the formation of consciousness and opinion, at the source of political decision-making" (Castells and Cardoso 2005, p. 12). Political support is fundamental to translating this diversity of consciousness and opinion into effective outcomes for "the context in which [an ecosystem services] initiative is implemented matters greatly for effective policy design and the achievement of stated goals. (Jack, et al. 2008, p. 9,469) The result, researchers posit, is that civic actors who harness information and context effectively "play an increasingly important role in ecosystem management" (Hahn 2011, p. 18).

SMA respondents' view that support for ecosystem services management was highest at the peer and local level reflects this connection between information and political support. SMA colleagues joined local government and the grassroots as strong reported sources of support while municipal foresters also reported each of these civic actors were the most frequent consumers of ecosystem service information the foresters provided. Respondents perceived the grassroots as valuable for their political backing for ecosystem services production rather than as a source of important information. The potential lack of professional expertise at the grassroots level could explain this, however, SMA members might also be missing a reciprocal opportunity to gain valuable local knowledge capable of enhancing their work.

Respondents viewed university scientists as (perhaps appropriately) predominantly neutral. However, nearly half (48.7 %) reported the scientific community as actively supporting their work. This figure indicates scientists, at least as regards urban ecosystem services, are actively engaged in the spirit of Lubchenco's call for a new Social Contract for science. The new Contract calls upon scientists to: "(i) address the most urgent needs of society, in proportion to their importance; (ii) communicate their knowledge and understanding widely in order to inform decisions of individuals and institutions" to meet human needs during the "century of the environment" (Lubchenco 1998, p. 495).

While SMA members rated local civic actors and much of the scientific community as actively supportive, they viewed developers as the greatest source of obstruction, both currently and in the future, to managing green space for the production of ecosystem services. While SMA respondents saw all parties increasing their support in the future in line with Goldman and Tallis's critical analysis (2008), they also perceived the relative pattern of support (or lack of support) to remain roughly the same.

Respondents ranking of the public sector, scientists, and colleagues as more valuable sources of information and influence than private sector sources also provides insight on concerns that new forms of environmental accounting and governance are overly vulnerable to capture by private sector interests. While some activists and researchers fear that the valuation of ecosystem services will open conservation to increased private sector influence, loss of public accountability, and marginal community participation, SMA respondents offered little evidence to this effect (Faulkner 2003; Harmes 2006; McCauley 2006; Robertson 2004; Sandercock 2005; Thomas and Littlewood 2010).

Rather, SMA members' perception of resistance to ecosystem services management by developers lends validation to Simpson's (2011) critical assessment which argues that valuation of specific, localized ecosystem services is still too underdeveloped, from the scientific, policy, and regulatory standpoint to motivate new behavior among individual private sector actors.

Despite the early stages of these factors in ecosystem services management, the lack of private sector support for ecosystem services is further evidence that consultants, developers, and vendors are coming late to the table of a considerable business opportunity. Given rising interest in green infrastructure investments, growing adoption of low impact development rules in municipalities, and respondents' perception that the network of political support is swinging decidedly in favor of ecosystems services as a means to deliver public goods amplifies the probability that this economic possibility may become a political inevitability. In either case it suggests that the private sector should get on board either in terms of investment, capacity-building, or forging the type of regulations, legal supports, and public incentives necessary to open an opportunity for private engagement.

Similarly, the federal government, facing the coming challenge of coordinating these infrastructure investments, should look to create more robust information networks with local practitioners such as the SMA. Reciprocal relationships in this arena also could raise the importance and profile of the federal government as a source of guidance on these issues. Such networks could further play an important role in developing the constituency support these investments will require.

The high level of local support for ecosystem services identified by SMA respondents suggests opportunities exist to build a broad-based, public/practitioner/grassroots coalition of engagement. Building this coalition will be vital for the scientific advancement and implementation of ecosystems services management as its "political feasibility depends on the political power of those who bear the costs and benefits" (Jack et al. 2008, p. 9,468). Such support will be the keystone to developing ecosystem services as the fundamental infrastructure of the living city.

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