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Assessing the Potential of Urban Ecology Research to Inform Municipal Sustainability Practices

Cities are increasingly making decisions related to sustainability, and information from the field of urban ecology may be useful in informing these decisions. However, the potential utility of this information may not translate into it actually being used. We surveyed municipal sustainability staff through the Minnesota GreenStep Cities program documenting their information needs and information sources, and used these results to identify the frequency with which urban ecologists are publishing studies of potential relevance to practitioners. We also quantified funded awards from the U.S. National Science Foundation in urban ecology that explicitly describe active partnerships with city policy makers. Our results show that urban ecologists are increasingly generating information of potential relevance to city sustainability efforts, with rapid increases in the number of articles published and grants funded on areas identified as key information needs. Our results also suggest that the transmission of information from academic urban ecologists to practitioners occurs mostly through indirect pathways, as municipal sustainability staff reported relying heavily on general web searches and government agency websites to find information. We found evidence of an increasing frequency of active collaborations between urban ecologists and policy makers from NSF grant abstracts. Our findings are consistent with previous findings that traditional models of passive communication to practitioners through academic journals results in a low efficiency of use of this knowledge, but that the potential for urban ecologists to help inform municipal sustainability initiatives through active collaborations with practitioners is great.

Keywords

Urban ecology, sustainability, alignment, municipal government

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INTRODUCTION

As human populations become ever more urbanized (UN World Population Prospects 2012), the sustainability of cities and their role in supporting human well-being has increasingly become a focus of basic and applied research. Whereas ecologists largely ignored human-dominated environments in the early 20th Century, urban ecology emerged as a sub-discipline of ecology in the 1970s, broadening in scope from an initial focus on ecology in cities to include ecology of cities, while integrating theory and methods from the natural and social sciences (Cadenasso et al. 2008; Grimm et al. 2008; McPhearson et al. 2013). Major research topics include land-use changes that accompany urbanization, altered hydrological and biogeochemical processes, the relationship between urbanization and climate change, provisioning of ecosystem services, and biodiversity changes in cities (Grimm et al. 2008; Wu 2014).

Cities are increasingly faced with making decisions related to sustainability, and urban ecologists may be able to provide information that helps inform these decisions. However, the traditional model of the scientific community generating knowledge from data and communicating findings primarily or exclusively through peer-reviewed scientific journal articles (Wynne 1992; Soranno et al. 2015) may result in a small fraction of this knowledge ever being used by practitioners. Potential barriers in translating ecological science to practitioners include: the narrowness of scientific disciplinary inquiry, the different perspectives on uncertainty and risk by scientists and practitioners, the lack of incentives for academic scientists to translate scientific findings to practitioners or the public, and the lack of inclusion of practitioners in designing many scientific studies (Jasanoff 1987; Szaroa et al. 1998; Guston 1999; Cash 2001). For scientific information to be effective in influencing policy, in addition to the information being accessible, it must also be perceived as credible, relevant, and unbiased (Cash et al. 2003). Partnerships between scientists and decision makers are most effective when researcher's questions are informed by information needs of decision makers, and ongoing communication is maintained (Cash et al. 2003; Berkowitz et al. 2003; Roux et al. 2006). There have been previous calls for ecologists to collaboratively engage with policy makers to address challenges related to conservation (Broberg 2003) and in urban planning (Pickett et al. 2004), but such an approach requires a high level of commitment, and incentives to translate research findings to policy-makers have been lacking in academia. Unlike the transmission of ideas in academic research (where citations are easily quantified), the transmission of information from researchers to practitioners is less transparent. Researchers may incorrectly assume that, because research has potential management implications, it is accessible to, and being used by, managers and policy makers (Roux et al. 2006).

Here, we present a preliminary analysis exploring the potential for knowledge transfer from academic urban ecologists to municipal sustainability staff in Minnesota. We identified key areas of information needs for municipal sustainability staff in Minnesota by surveying municipal staff in the Minnesota GreenStep Cities program, and we then quantify the number of publications by urban ecologists focusing on these topics over time from 1980-present. We also used survey data to document where municipal sustainability staff typically sought information, and whether they had directly consulted with scientists. To broaden our analysis, we also documented direct partnerships between urban ecologists and city decision makers (both in the

United States and internationally) described in published abstracts of U.S. National Science Foundation urban ecology-related research grants.

METHODS

Survey of Municipal Sustainability Staff

We surveyed municipal sustainability staff across Minnesota by distributing an electronic survey through the Minnesota GreenStep Cities program. The GreenStep Cities program (<https://greenstep.pca.mn.us>), an initiative of the Minnesota Pollution Control Agency, is a network of over 100 municipalities throughout the state of Minnesota that have made commitments to achieving sustainability goals and share best practices and resources. Survey questions asked how often staff needed to find information about eleven different topics related to urban ecology the specific type of information they need, and the sources that they use to find this information. These topics (Table 1) were based on reviews of the field (Grimm et al. 2008; Wu 2014), and we included an additional open-ended response category for any relevant topics that were not included in these categories. To provide additional depth to survey responses (Kelly et al. 2003), we also asked several open-ended questions asking for examples of a time when they have successfully and unsuccessfully searched for specific information, and also whether they have ever requested help from scientists in researching a particular question. Survey questions were developed with input from GreenStep Cities program staff. This survey was approved by the University of St. Thomas Institutional Review Board (446348-3). For supplemental information, follow-up telephone interviews were conducted with three respondents who had given us permission to contact them. During these interviews, we asked more detailed questions regarding how these individuals find information and interact with scientists.

Quantification of Published Urban Ecology Research

We searched Scopus for research or review articles containing “urban ecology” in the title, abstract, or key words, from 1980-2018. The total number of articles, and the number of open-access articles, were reported in five-year intervals (1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014, 2015-108). We then used the top six areas of information needs determined from the survey above (stormwater management, invasive species, stream/lake management, species/habitat conservation, urban forestry, and carbon sequestration), and combined each of these search terms with “urban ecology”, to document the number of resulting articles (both total, and open access) in each five-year interval.

Analysis of Grant-Supported Direct Outreach Efforts

We documented U.S. National Science Foundation (NSF) awards in urban ecology that describe direct outreach efforts to local policy-makers. We used the “Search Awards” function on the NSF website, using “urban ecology” as the search term. Both active and expired awards were included in the search. We used the published abstracts to assess whether the project potentially generated information of relevance to municipal sustainability staff (based on topics identified in the survey). We also documented whether the project abstract explicitly describes direct

outreach activities aimed at local policy-makers or managers. We acknowledge that this is a conservative measure of impact, as projects may have included outreach efforts aimed at local policy-makers that were not described in project abstracts.

RESULTS

Survey of Municipal Sustainability Staff

We received 38 responses to this survey, representing 35% of the 109 municipalities enrolled in the Minnesota GreenStep Cities Program at the time of our survey. Job titles of respondents included board member, city manager, clerk, engineering services manager, environmental specialist, finance director, mayor, and planning intern. We note that not all cities have specific staff positions devoted to sustainability.

Stormwater management was the most common topic on which survey respondents reported needing information, with 44% of respondents reporting searching for information within the past year. Invasive species/pest management was next (24% of respondents searched for information in the past year), followed by stream/lake management (16%), species/habitat conservation (16%), urban forestry (13%), and carbon sequestration (11%). Fifty-five percent of respondents reported seeking information on best management practices, 47% reported searching for regulatory information, 42% reported searching for engineering standards, and 29% have sought results of scientific investigations. General internet searches were the most common method used to find information (45% of respondents had used this method to search for stormwater management information in the past year), followed by state agency websites and the Minnesota GreenStep Cities website (39% each), federal agency websites and professional/trade organizations (21% each). Respondents cited specific federal agencies (USDA, EPA, U.S.

Table 1. Percentage of municipal sustainability coordinators who reported accessing information on each topic through the six different sources. (n = 38 respondents).

| Category | Peer-reviewed scientific journal articles | Federal agency | State Agency | Minnesota GreenStep Cities website | Professional / trade organization | General web search |
|----------------------------|-------------------------------------------|----------------|--------------|------------------------------------|-----------------------------------|--------------------|
| Animals as disease vectors | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 2.6 |
| Biodiversity | 0.0 | 2.6 | 2.6 | 0.0 | 2.6 | 2.6 |
| Carbon sequestration | 0.0 | 2.6 | 2.6 | 10.5 | 2.6 | 10.5 |
| Ecosystem services | 0.0 | 0.0 | 2.6 | 0.0 | 2.6 | 2.6 |
| Green infrastructure | 2.6 | 10.5 | 10.5 | 15.8 | 7.9 | 21.1 |
| Invasive species | 7.9 | 7.9 | 18.4 | 13.2 | 10.5 | 21.1 |

Table 1, Continued.

| Category | Peer-reviewed scientific journal articles | Federal agency | State Agency | Minnesota GreenStep Cities website | Professional / trade organization | General web search |
|------------------------|-------------------------------------------|----------------|--------------|------------------------------------|-----------------------------------|--------------------|
| Stormwater management | 15.8 | 21.1 | 39.5 | 39.5 | 21.1 | 44.7 |
| Stream/lake management | 2.6 | 5.3 | 10.5 | 7.9 | 13.2 | 15.8 |
| Urban agriculture | 0.0 | 0.0 | 0.0 | 2.6 | 0.0 | 2.6 |
| Urban forestry | 0.0 | 2.6 | 13.2 | 10.5 | 7.9 | 13.2 |

Forest Service, U.S. Fish and Wildlife Service), state agencies (Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, Minnesota Department of Health), local government units or other local organizations (counties, watershed districts, lake associations, soil and water conservation districts), and professional organizations (TreeCity USA, North American Lake Management Society, Minnesota Shade Tree Advisory Committee). Fewer respondents reported searching peer-reviewed scientific journals in the past year for information on stormwater management (16%), invasive species/pest management (8%), stream/lake management (3%), and species/habitat conservation (3%). No respondents reported searching peer-reviewed scientific journals for information on urban forestry, biodiversity, ecosystem services, carbon sequestration, urban agriculture, or animals as disease vectors (Table 1).

The open-ended survey question asking for an example of a successful information search received 11 responses, and these generally illustrated a process of starting with a general web search leading to a government agency website or directing them to qualified experts. For example:

- *I use the web for 99% of my searches. It provides a lot of information, and examples.*
- *Key words or GreenStep Cities website*
- *I needed to understand more about dredging a river with a dam. This was primary done through a web search to learn which other MN cities had experience with doing this. It also led me to the MPCA guidance on managing dredged materials. I wanted to learn more about what were the contaminants levels in the sediment and how to properly manage the different levels of contamination.*

In cases where the internet search does not lead to a clear recommendation, outside experts are commonly consulted:

- *Most searches start as a google search that leads me to reputable sources such as federal/state agencies or organizations. If this does not pan out, I try to find someone who can answer or direct me to someone else.*
- *I rely heavily on searching multiple websites, but I also make phone calls and meet with experts in the fields.*
- *I looked for standards for the interrelation between groundwater protection guidance and stormwater infiltration guidance. I was looking for regulatory, BMP, and standards*

information. Found both MDH [Minnesota Department of Health] and MPCA [Minnesota Pollution Control Agency] guidance that conflicted, and then made a judgment call based on a review of the topic from professional sources.

We received only two responses to the question asking for examples of a time when they had been unable to find information. One of these responses reflected either lack of information on a specific topic:

- *There is not enough research about sourcing and engineering for cheaper tree boxes and ways to protect trees from soil salt. We need to plant a lot more trees on sites but the availability of salt and aerial tree species to select from is minimal.*

The other response reflected an abundance of information that was difficult to synthesize:

- *Our current question we have not found is a comparison of our lake with other MN lakes in terms of water quality, size, etc. This information is hard to sift through and county/state agencies have not been able to assist.*

The third open-ended question asked whether cities had ever requested help from scientists to research a particular question. Out of eight responses, three had not worked directly with scientists. The others, however, had worked with scientists through a variety of pathways:

- *I have met with representatives from nonprofits, government officials, and others to research issues and opportunities related to the above topics.*
- *We've worked with UMN Water Resource Center on LRRB grant proposals, and we've reach out to UMN Capstone design teams on both transport and utility issues.*
- *University of Minnesota Forestry Department and consulting engineers for things like stormwater.*
- *We currently work with the University of St. Thomas as a Sustainable Communities Partner. This pairs us up with professionals and their students for a number of projects. We have also worked with the Center for Sustainable Building Research to assist with sustainable building practices that will utilize scientific data.*
- *We have worked with 3 classes and researchers from UMN, so very comfortable with this.*

In the three follow-up interviews, stormwater and surface water management were noted as common concerns. Respondents indicated that information was often sought using search engines, and scientific articles were rarely sought out. A common concern among these staff was the difficulty of interpreting peer-reviewed journal articles, and one noted that “it was above their pay grade.” One individual stated that it should be the responsibility of the state to interpret primary literature and then pass that information to local coordinators. Those coordinators working close to universities often sought academic scientists to answer their questions. They reported that the experience of working with scientists was overwhelmingly positive, and that their insight was applicable to the coordinator’s current projects. One individual stated, “We are very fortunate to have scientists in the community.”

Quantification of Published Urban Ecology Research

The number of published urban ecology articles has increased rapidly, from approximately 5 articles/year published in the 1980's to well over 100 articles/year in recent years (Fig. 1). The fraction of these articles that are open access has also been increasing, from <10% before 2005 to >25% post 2015. The number of urban ecology articles on topics pertaining to potential information needs by cities has also increased rapidly in recent years (Fig. 2). These trends suggest that urban ecologists are increasingly working on issues of potential relevance and have information and expertise that could be valuable to city sustainability staff.

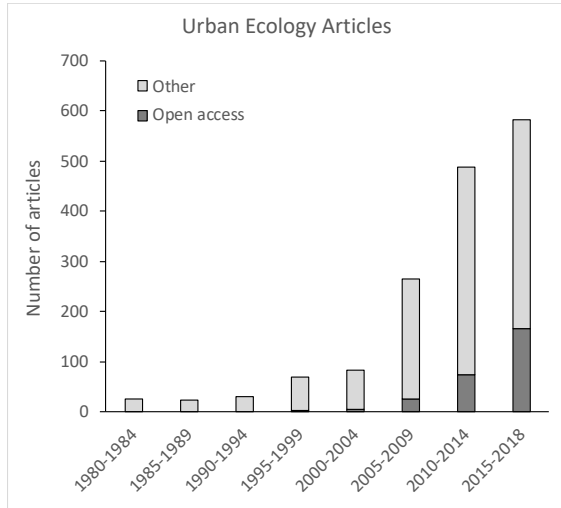


Figure 1. The total number of urban ecology research and review articles, and the number of these articles that are open access, has increased rapidly in recent years.

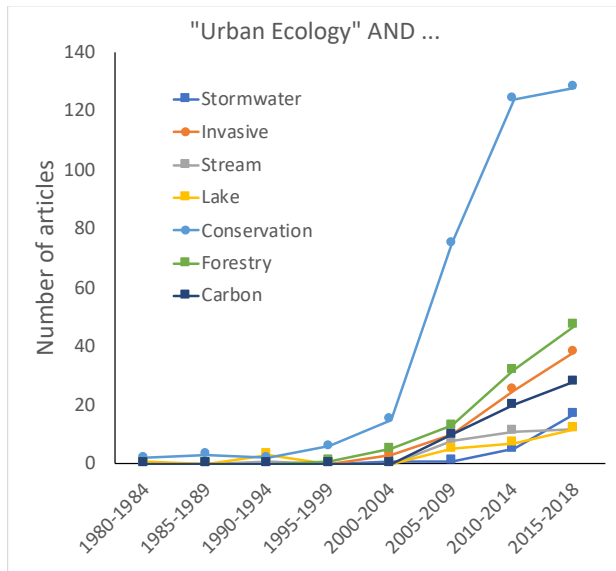


Figure 2. The number of urban ecology articles related to topics identified as potential information needs by municipal sustainability coordinators has increased rapidly since 2000.

Analysis of Grant-Supported Direct Outreach Efforts

A search for “urban ecology” returned 109 awards. Of the 109 resulting awards, we identified 47 unique awards (collaborative awards for multiple institutions were only counted once) that we determined to be likely to generate information of potential relevance to municipal sustainability staff. Of these, 29 abstracts (62%) explicitly described outreach efforts or partnerships with local policy-makers (Table 2). The number of NSF urban ecology grants of potential relevance to policy-makers increased over time, with 38 having start dates of 2005 or later, and only 9 with start dates prior to 2005.

Table 2. Number of U.S. National Science Foundation Awards related to urban ecology that focus on topics of potential interest to municipal policy-makers, and the number that explicitly describe outreach efforts aimed at municipal policy-makers.

| | Focuses on topic of interest to city policy makers | Abstract explicitly mentions outreach to city policy-makers |
|-----------|-----------------------------------------------------------|--------------------------------------------------------------------|
| Pre-2000 | 3 | 2 |
| 2000-2004 | 6 | 2 |
| 2005-2009 | 19 | 14 |
| 2010-2014 | 16 | 10 |
| 2015-2017 | 3 | 1 |

DISCUSSION

Our results indicate that as the field of urban ecology grows, urban ecologists are increasingly generating information of potential relevance to city sustainability efforts. The number of research grants funded and scientific articles published on topics identified by municipal sustainability staff as key information needs is expanding rapidly. Moreover, an increasing number of these articles are open access, potentially increasing their accessibility to non-academic audiences.

Few municipal sustainability managers reported directly accessing peer-reviewed scientific journal articles (although this number was somewhat higher for stormwater management). Rather, our results suggest that the transmission of information from academic urban ecologists to practitioners occurs mostly through indirect pathways, as municipal sustainability staff reported relying heavily on general web searches and government agency websites to find information. This finding underscores the important role that agencies and sustainability organizations have in translating and synthesizing research findings for practitioners. The fraction of information on sustainability-related government websites that originated from academic urban ecology research is not clear; for example, the Minnesota GreenStep Cities website “Best Practices” page cites both governmental reports and academic articles in describing benefits and providing implementation tools for various sustainability initiatives.

We found evidence of an increasing frequency of active collaborations between urban ecologists and policy makers from NSF grant abstracts. These abstracts described a variety of direct approaches to supporting municipal sustainability staff, including scientists publishing in venues aimed at managers, hosting workshops in which scientists and policy makers work collaboratively, and providing specific training for science graduate students in engagement with policy-makers. An analysis of 296 funded NSF Ecosystems proposals from 2000-2009 found that only 65% included a Broader Impacts Statement, and that these focused primarily on academic audiences (Nadkarni and Stasch 2013). Our results suggest that urban ecologists may be more likely than other ecologists to engage with policy-makers, and that these numbers are increasing over time. Comments from survey respondents in our study indicate that their partnerships with scientists have been positive. Respondents reported having good experiences working with local scientists on applied problems, suggesting that such partnerships can be effective when urban ecologists are attuned to the specific questions of managers. While dedicated partnerships between scientists and stakeholders can be effective (NRC 1996; Couvet et al. 2008; Sorrano et al. 2015), a lack of incentives by universities and the academic community to engage with professionals in solving applied problems may be a barrier to wider implementation. New models pairing course projects with municipal partners may be one method to increase the level of community engagement by scholars (Alexander and Pushnik 2017; Schlossberg et al. 2018); two of our survey respondents specifically cited these course-based partnerships.

Our findings suggest that previous calls to make urban ecology research accessible for practitioners (e.g. Pickett et al. 2003; Ahern 2012; Childers et al. 2015) may be coming into fruition, as the number of published articles and fund grants on topics identified as areas of information needs by municipal sustainability staff has rapidly increased in recent years. It is less clear what fraction of this information is accessible to and ultimately used by municipal staff, as staff rely heavily on information translated through government agency websites. Quantifying the fraction of potentially relevant academic urban ecology research that is translated for practitioners by government agencies is an important area for future study. Our findings are consistent with previous studies showing that the deficit-linear model of knowledge generation by researchers and passive communication to practitioners through science journal articles is likely to yield a low efficiency of usage of this knowledge. We would caution urban ecology researchers against assuming that results of urban ecology studies will necessarily be useful to, or accessible to, managers and decision makers, just because the research focuses on a human-dominated study system. However, the potential for urban ecologists to help inform municipal sustainability initiatives through active collaboration with practitioners is great.

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