Planning for Change in the Boston Metropolitan Area (USA): Exploring the relationship between urban greening and socio-economic processes

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Introduction

Global population growth is increasingly concentrated in urban areas, degrading natural resources and threatening long-term sustainability of both human and biotic systems. Even in a developed nation like the United States, urban areas are expected to double in population and land area over the next fifty years (UNFPA, 2007). In order to plan for a more sustainable urban future, there is a need to understand the relationship between the socio-economic forces that are driving land use and land cover change, and the resulting impacts upon the ecosystem state and structure of the urban forest (Colding, 2007). In particular, this study will focus upon the role of urban greening projects in preserving urban open space, restoring ecological processes, and building stewardship of urban nature by local residents.

Urban greening is a spatially distributed form of land use-land cover change with diverse drivers and potential outcomes. In this framework changes in ecosystem state and structure, including the delivery of ecosystem services and other benefits to human well-being, are recognized as the aggregate outcomes of many local acts (e.g. tree-planting, riparian restoration, and community gardening). Each can be treated as opportunistic experiments, with testable predictions regarding their consequences, (e.g., for biodiversity, air quality, and fluxes in water and nutrients). From this perspective urban greening can be placed in the context of broader scale processes of urban-associated land use/land cover change.

In order to explore these issues, an interdisciplinary team was formed to develop a long-term research study for the Boston Metropolitan Area to provide a model for scientific investigation and to address the critical needs of urban communities.

Background/Literature Review

The study of urban ecosystems is rather new in the field of science, despite the fact that many urban regions contain critically endangered natural resources (Pickett et al., 2001; Botkin and Keller, 1995). Urbanization is a major threat to worldwide biodiversity (Vitousek et al., 1997). Urban ecosystems provide vital ecosystem services for human populations including drinking water, climate moderation, flood protection, and clean air (Benedict and McMahon, 2006). In addition, exposure to urban nature provides valuable human health benefits in the form of places for physical activity and recreation and psychological restoration (Ryan, 2006; Kaplan and Kaplan, 1989).

The public health benefits of urban parks and other urban green spaces was the impetus for the great urban parks movement of the nineteenth century led by landscape Frederick Law Olmsted (Fabos, 2004). Greenways as linear corridors of green space provide many of these health benefits as well (Fabos and Ahern, 1995). Recently, there has been a resurgence in recognition of the human benefits of urban green space (Jackson, 2003; Inerfeld and Blom, 2002), especially involving urban residents in ecological restoration and tree planting projects (Hull and Gobster, 2000). The benefits of this new form of urban greening include increased citizen awareness and appreciation of urban nature (i.e., place attachment), as well as stewardship of existing natural areas (Ryan et al., 2001). However, little work has looked at the cumulative effects of these greening projects on the overall urban ecosystem (James et al., 2009). Moreover, from an institutional perspective, it would be important to know if these "grass root" efforts have translated into public policy goals and decisions at the local government level.

At the metropolitan scale, landscape transformation in the form of urbanization has led to significant loss of habitat and biodiversity (Marzluff 2001). This is especially troubling as forested lands provide critical ecosystem services including riparian buffers, water filtration and carbon sequestration (Brauman et al., 2007). Landscape and greenway planning has been critical in identifying valuable environmental corridors in the face of new development (Fabos and Ahern, 1995). The planning challenge has been to implement large-scale greenways and other landscape preservation efforts across a metropolitan landscape fragmented between many political jurisdictions (Erickson, 2006). Public policy decisions at the local scale are often uncoordinated with neighboring jurisdictions, and there are many barriers to cross-boundary collaboration, including the lack of shared goals, leadership, and institutional structure (Ryan et al., 2006). There has been little study conducted on the effects of these institutional decisions as drivers of landscape change at both the local and regional level.

Socio-economic forces play a significant role in the spatial composition and amount of urban green space. Lower income urban neighborhoods often have less vegetation and lower biodiversity than wealthier portions (Iverson and Cook 2000, Kinzig et al. 2005, Melles 2005). Likewise, wealthier communities may have more resources, as well as social and political connections to preserve natural resources and green space within their borders. Thus, across the metropolitan scale, one may expect to find regional differences in protected land and biodiversity based upon community socio-economic status; however, more research is needed to support this claim.

Goals and Objectives

The goal of this study was to understand the relationship between socio-economic forces (i.e., human behavior, institutions, and perceptions) and urban ecosystem patterns and processes across a metropolitan region. In particular, it will address the following questions:

A. How have historical and social processes led to regional and local land cover transformations, producing current patterns of ecosystem state and structure?

B. Which social drivers and intervening biophysical processes link most strongly to particular social, ecological and health outcomes?

C. What is the future of the Boston Metropolitan area under different landscape change scenarios?

Study Area

As a mature urban area with almost four centuries of settlement, the Boston Metropolitan region creates a unique microcosm to study how institutional forces and socio-economic processes have affected landscape pattern and settlements. The Boston Metropolitan Area is the 10th most populous region in the United States with 4.48 million people (US Census Bureau 2007), yet the state of Massachusetts ranks 8th in the nation in percentage forest cover and the vast majority of forests (70%) are privately owned.

The metropolitan region for this study covers 101 towns and cities of the Metropolitan Area Planning Council (Figure 1). The metropolitan area has a remarkable diversity of socio-ecological settings from high density urban core with large tracts of protected "urban wilderness" to surrounding suburbs that vary in density, age, and bio-physical features. The focus on town rule form of governance makes regional planning difficult, but from a research perspective provides a myriad of replicates for testing the effects of policy on social and ecological outcomes. Despite relatively low levels of population growth in the next 20 years, the metropolitan area is expected to consume 152,000 acres of open space, including 58,000 acres of rare and endangered species habitat (Metro Future, 2009). Moreover, the Boston study area has already experienced the impacts of global climate change as the urban heat island has brought warming to record levels with detectable effects on plant and animal communities (Miller-Rushing et al. 2008).

Dealing with this predicted growth will require proactive landscape planning in the developing urban fringe, as well as increased "greening" of the existing densely populated urban core. Fortunately, Boston has a long history of urban greening with America's first public park, the Boston Common in 1640 to the nation's first greenway, Frederick Law Olmsted's Emerald Necklace in the 1800's. In the last century, a metropolitan system of parks was created by Charles Elliot (Fabos, 2004). Recent urban greening initiatives in Boston include the Rose Kennedy Greenway (above a new underground highway) and the award winning Boston Schoolyard Initiative (www. schoolyards.org) to transform asphalt covered schoolyards into community-designed interactive educational areas. Furthermore, Boston's Mayor Menino has pledged that the city will plant 100,000 trees to improve urban neighborhoods and combat global climate change. One of the challenges of this study is to help determine strategies to maximize the social and ecological benefits of future urban greening projects.

It is under this rich history of urban greening projects that an interdisciplinary long-term research program was developed for the Boston Metropolitan Area to understand the historical and socio-economic processes that led to the current landscape pattern and to project future landscape change scenarios for the region. This project team involves the City of Boston, non-profit Urban Ecology Institute, and researchers from six universities, including the University of Massachusetts-Amherst, Clark University, and Boston College. The Urban Ecology Institute (UEI) is an independent not-for-profit organization housed at Boston College that promotes the health of underserved communities of greater Boston through research, education and community transformation, emphasizing green infrastructure (www.urbaneco.org).

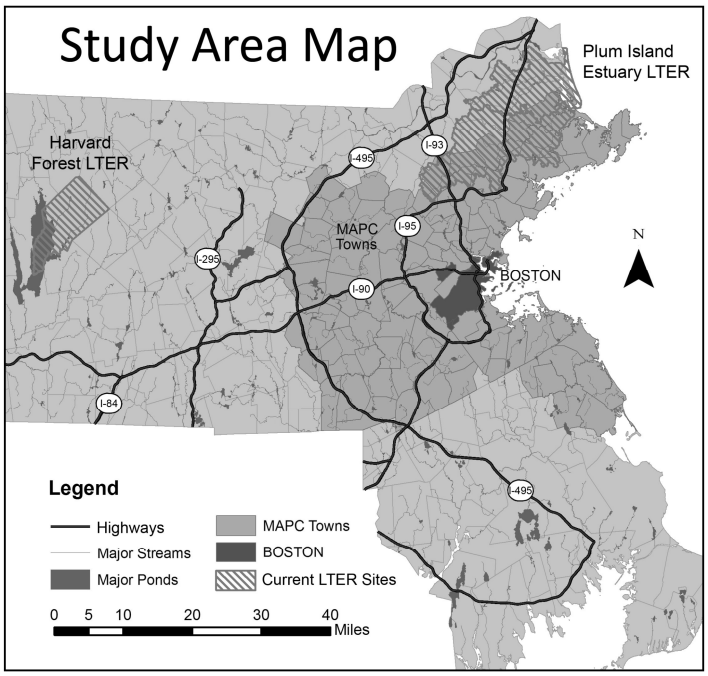

Figure 1. Boston Study Area

Methods

Research Plan

The overall project incorporates a series of inter-related studies by a diverse team of ecologists, social scientists, and planners, which capitalizes on existing and future urban ecology research efforts in the study area. These studies will look at the current state of green infrastructure and greening efforts in the City of Boston, including the progress to plant the 100,000 new trees along with tree survival and mortality. At the metropolitan scale, it will use land use and land cover data to study current patterns and historic change over a thirty year period.

The studies of biophysical processes will look at biodiversity in urban neighborhoods using citizen scientists to understand the relationship between shrub and tree cover and bird and arthropod populations (Kinzig et al., 2005). The team will also study the impact of climate change and urbanization on invasive insect species that threaten the urban forest, as well as the effects of urban land covers and soil conditions (Byrne 2007). Water quality studies will build upon previous work by team scientists by assessing the effects of land use, land cover, and climate change upon aquatic health (Wollheim et al., 2008; Randhir, 2003).

Several studies will look more directly at human-environment relationships as manifested in public health. An air quality monitoring study at the local level will explore the role of urban tree projects in improving urban air quality (Buonocore and Levy, in press). At the metropolitan scale, research will be conducted to explore the relationship between obesity, as an indicator of health risk, and the amount and type of nearby urban forest cover (Lopez, 2007).

Human-environment relationships are strengthened by neighborhood participation in urban greening projects, which may build higher levels of social capital and stronger connections to the local environment (Austin, 1999). At the individual level, volunteer stewardship participation may result in stronger appreciation and attachment for local natural areas creating increased advocacy for restoring urban nature (Ryan et al., 2001; Miles et al., 1998). To test these relationships, this study will conduct a survey of urban greening volunteers to determine the effects of their participation on environmental knowledge, attitudes, behavior, and place attachment (Ryan, 2005).

Finally, the study will develop a set of landscape scenarios to outline different alternative futures based upon our scientific findings for local stakeholders, citizens, and government officials to evaluate at public workshops and using an interactive web-site.

Pilot Study Methods

Since this research project is in the beginning stage, this paper will describe the initial results from a pilot study of land-use and land cover change for eight towns along the rural-urban gradient in metropolitan Boston. In this pilot study, we identify the institutional factors that contribute to stability of open space and forest cover within the towns by using a policy analysis of open space and planning documents and interviews with local officials.

The eight towns that were selected were spatially located along a major highway corridor that radiates northwest from the City of Boston, and varied in their amount of population change and related urban forest cover. The town-unit of government is an independent political jurisdiction dating from colonial times that govern the majority of land use decisions, rather than regional or state levels of government.

Geographic information from the state of Massachusetts was used to determine the percent of existing forested land (public and private) and percent protected forest land. In addition, population change was calculated over a three decade period using US Census data along with data on each town's socio-economic condition.

A policy analysis of local open space planning documents was conducted for each town. The plans' goals and objectives were analyzed for statements regarding urban forests, street trees, and other open space features. In addition, statements regarding the town's progress in protecting land for conservation were assessed. The details of this methodology can be found in Warren et al., forthcoming. In addition to the analysis of planning documents, hour-long interviews were conducted with town planning officials to broaden our understanding of the town's open space goals, implementation, and actions. Themes from these interviews were categorized and analyzed as they related to key issues about the level of funding for conservation, including staff; the length of time conservation staff had been employed; and the role of non-profit organizations, such as land trusts, land conservation/

Pilot Study Results

Our preliminary findings indicate that non-profit land conservation trusts play a significant role in acquiring and maintaining land for conservation purposes, often aided by municipal investment in conservation staff (as also found by Miller et al. 2009; Donahue, 1999). Wealthier communities were also more likely to have land trusts, conservation staff and more protected areas. The importance of local leadership in preserving open space is critical whether this comes in the form of government conservation staff or non-profit organizations.

We also found that more urban, higher density communities often had higher percentages of protected open space. For example, the City of Boston has a surprising 21% of its land area as protected open space, which is primarily the legacy of Olmsted's work along the Emerald Necklace. However, as might be expected in this high density city, only 5.56% of Boston is forested. More outlying suburban communities often had larger overall percentages of undeveloped forest land, but the majority was in privately held forest and farmland, which is especially vulnerable to urbanization. The exceptions were large blocks of protected forest lands that were often associated with regional water supply lands and wildlife refuges. These conservation lands were the legacy of statewide or regional agency efforts over previous decades rather than the outcomes of local policy. There is a need for further research into the effect these large protected lands have on local planning efforts, as it may be that local residents see less urgency to preserve additional town land with these historic tracts of state conserved land.

Our initial analysis showed little relationship between the policy statements and goals in the open space plans and the actual percentage of town land that was conserved. There could be several reasons for this discrepancy. First, open space acquisition is a long-term strategy that can take many decades to implement, which

may be why we did find a relationship between the duration of conservation staff and protected open space. Second, open space plans in Massachusetts are guidelines for planning and applying for state grants, but are not regulatory or binding documents.

Discussion/ Conclusion

The results of this pilot study can help greenway planners understand the institutional framework and socio-economic forces that impact greenway planning and development. Our preliminary study results support previous research that explored the relationship between socio-economic status and amount of protected open space. Previous research in more urban settings found that lower income neighborhoods have less open space than wealthier neighborhoods (Iverson and Cook 2000, Kinzig et al. 2005, Melles 2005). We found these same relationships held true at the municipal scale across the rural-urban gradient, which suggests the need for more state and federal support for land conservation in lower income communities who have minimal resources for land acquisition.

Greenway planners will likely struggle with these same resource issues when planning large-scale greenways that traverse a variety of municipal areas. Erickson (2006) in her study of metropolitan greenways found the importance of a regional agency to coordinate multi-jurisdictional greenways. Regional agencies may also be useful in equalizing the ability to implement greenways and conservation planning between towns with different socio-economic resources. The regional park agency in metropolitan Boston, the Metropolitan District Commission, which is the legacy of Charles Elliot (Fabos, 2004) provides one such model for a coordinating agency in the region.

In our study, local land trusts played a key role in municipal open space conservation. At the regional scale, statewide land trusts such as the Trustees of Reservations, a Massachusetts based land trust and the first in the nation, could play a critical role in coordinating conservation efforts across the metropolitan area. Likewise, state planning agencies which have their own statewide biodiversity map could be another key player in regional efforts.

Lastly, one of the goals of our overall study is to inform conservation planning with scientific based information about ecosystem changes wrought by urbanization, climate change and other drivers. Research of this Boston Metropolitan Area long term research project will help the region plan for a more sustainable and resilient future in the face of dramatic global environmental changes.

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