Scenario Planning for the Boston Metropolitan Region:
Exploring Environmental and Social Implications of Alternative Futures

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The Boston Metropolitan Area Urban Long-term Ecological Research Area (BMA-ULTRA-EX) Project is an interdisciplinary project that is studying the effects of socio-economic and bio-physical drivers on urban ecosystems. The Boston region is experiencing low-density urban sprawl (suburbanization) on the rural-urban fringes of the metropolitan area that is creating environmental impacts to natural resources. At the same time, central cities such as Boston are seeing disinvestment in some low-income neighborhoods causing property abandonment, along with limited infill development (densification) near the commercial core and transit hubs. These competing socio-economic forces of suburbanization, densification, and disinvestment have environmental implications for urban ecosystems, including urban forest canopy, water quantity and quality, and biodiversity. Landscape planning initiatives to address these issues will require a pro-active approach to concentrating development on currently built lands and in the suburban fringe to protect forests, farms and other natural resources, while greening and enhancing ecosystem services in the current high-density urban core.

It is within this landscape planning setting that the research team used a stakeholder- driven process to develop a set of four planning scenarios to explore the future of the region. This paper will describe the planning process with stakeholders to develop these plans, along with the preliminary analyses. It will conclude with insights for other landscape planners engaged in scenario planning.

Background

Scenario planning is a unique tool that allows planners to visualize alternative futures in order to deal with temporal change and multiple spatial scales (Myers and Kitsuse, 2000). Scenarios are flexible and adaptable to potential future conditions; providing a strategy for responding to the uncertainty inherent in land use planning (Peterson et al., 2003; Klosterman; 2007; Steinitz et al., 2003). They allow planners to develop benchmarks that illustrate the implications of different futures for a range of systems, including economic, ecological, and social. They are also very useful tools for engaging stakeholders and the public in landscape planning by showing them the ramifications of different decisions, making the planning process more visible and transparent (Gunder, 2008).

The Boston Metropolitan Region with a population of 4.48 million is the 10th most populous in the U.S., yet is expected to only experience moderate population growth in the coming decades. However, new development, primarily at the urban fringe, is expected to consume 152,000 acres of open space, including 58,000 acres of rare and endangered species habitat (Metro Future, 2009). This urban sprawl has precipitated planning efforts to try to concentrate new development within existing urban centers. At the same time, Boston has a long history of proactive open space planning beginning with Olmsted's Emerald Necklace to create a multifunctional greenway in this densely populated city (Fábos, 2004). Currently, Boston's

Mayor Menino has pledged to plant 100,000 trees to increase the urban tree canopy, as well as completed the Rose Kennedy Greenway on top of the Central Artery Project.

It is under this rich history of urban greening projects that an interdisciplinary 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, led by the University of Massachusetts Amherst. The project was funded by a new joint initiative of the National Science Foundation and USDA Forest Service known as the ULTRA-Ex (Urban Long-term Research Areas Exploratory) program.

The research team developed a set of four scenarios in conjunction with stakeholder groups to understand the competing forces of **urban greening** at the local scale, and **urban growth**, including suburbanization and densification at the larger scales. Urban greening, including tree planting and community gardens, allowed us to study the impacts of municipal investment in community-focused small-scale projects on the larger ecosystem-scale. In addition, we studied the impact of different controlled growth efforts on population, housing density and subsequent land-use and land-cover changes at the city and metropolitan scales. We also explored the relationship between these two forces of urban greening and controlling growth.

Goals and Objectives

Our goal was to develop alternative future growth scenarios in the Boston Metropolitan Region with stakeholder input that aim to:

- Explore outcomes for people and the environment of different levels of investment in urban greening, particularly tree canopy cover in already urbanized areas;
- Quantify impacts on both people and the environment of varying levels of restrictions on suburbanization versus the impacts of increased densification in inner core communities;
- Identify potential tradeoffs, constraints and unforeseen consequences of four different combinations of greening investment (or disinvestment) and controlled or uncontrolled growth.

Each scenario takes a regional perspective and looks at population changes in urban inner core, suburbs, and region. Our workshops focused on the Boston and inner core portion, and other studies are looking at impacts on the suburbanizing portion of the region, focusing on the Ipswich watershed. The combined results of the scenario analysis will support policy makers and nonprofits in their ongoing efforts to engage the public in achieving a sustainable future.

Scenario Planning Process

Our study builds on the existing planning studies for the region: the Metropolitan Area Planning Council's (MAPC) MetroFuture plan (http://metrofuture.org). We used the MAPC's population projections for the region, and detailed sub-units, called Transportation Analysis Zones (TAZs) in order to determine future land use for the 101 municipalities in the Boston Metropolitan Area, including the City of Boston. The scenarios were developed in conjunction with 45 stakeholders from 18 organizations during two workshops. At the first workshop in spring 2011, the research team presented a range of preliminary scenarios that stakeholders selected and modified for

future development. The research team then developed tools and projected draft maps of future population growth in Boston and in the broader metropolitan area under each scenario. At the second workshop in spring 2012, academic researchers, non-profit members, and municipal and state decision makers gathered to provide feedback on these draft scenario maps and analyses. The research team made modifications to the analysis and continues to work on more detailed regional-scale land-use change projections.

Scenario Descriptions

The first scenario (Current Trends) follows the status-quo of uncontrolled growth with increased urban sprawl and increasing socio-economic inequities between suburbs and the central core cities. The other three scenarios (MetroFuture, Green Equity, and Compact Core) have some form of controlled growth, but differ in the ratio of new development allocated to the central cities and suburbs. The MetroFuture scenario is based on MAPC's existing plan that includes densification of the inner core cities and regional centers, which slows the rate of suburbanization and protects more open space and farmland than the Current Trend scenario. The Green Equity scenario prioritizes greening lower-income communities over urban density, while reducing inequalities in tree canopy cover. Urban greening is prioritized over urban density or protection of open space and farmland outside the urban core. Finally, the Compact Core scenario concentrates population and economic investment infill in inner cities such as Boston but downplays urban greening efforts. This strategy slows development in the outer-ring suburbs, which protects large tracts of connected open space and farmland.

Scenario Development Methodology

We used the MAPC's existing population projections for the MetroFuture and Current Trends plans. For the Compact Core, the growth rate for the inner core communities was increased, which resulted in a suburban growth rate of approximately half the Current Trends scenario. The population growth was then used to project changes in land use and urban tree canopy for the planning sub-units (TAZ's) within the study area. We used simple rules described above to allocate the amount of new development to different land use categories.

Based on MAPC's population projection in each TAZ, we used the demand of housing units as an indicator in gauging the potential housing density change for estimating associated land use and land cover change in the Boston Metropolitan Area. Several steps have been involved in transforming MAPC's population projection into land use and land cover change. First, developable lands based on zoning allowance and protected open space were identified, including current commercial, industrial, and residential land uses that could be infilled and redeveloped to accommodate projected housing units increase. Second, assumptions for a range of projected density increase in the Boston Metropolitan Area were made from very low density (more than one housing unit per acre) in rural communities to very high density (up to 200 housing units per acre) in the urban core areas. Finally, a set of decision rules were made to allocate projected housing units in each TAZ between inner core and non-core (suburban and rural) communities based on MAPC's projected development trends in greenfill (development on unprotected forest and agriculture lands) and infill (redevelopment in existing commercial and residential lands) in the region. The scenarios allowed us to study varying distributions of growth across the region, which were based upon allocating the projected regional population to

different areas. Thus, while the regional population changes were similar, the allocation of growth between suburbs and the inner core differed (Figure 1).

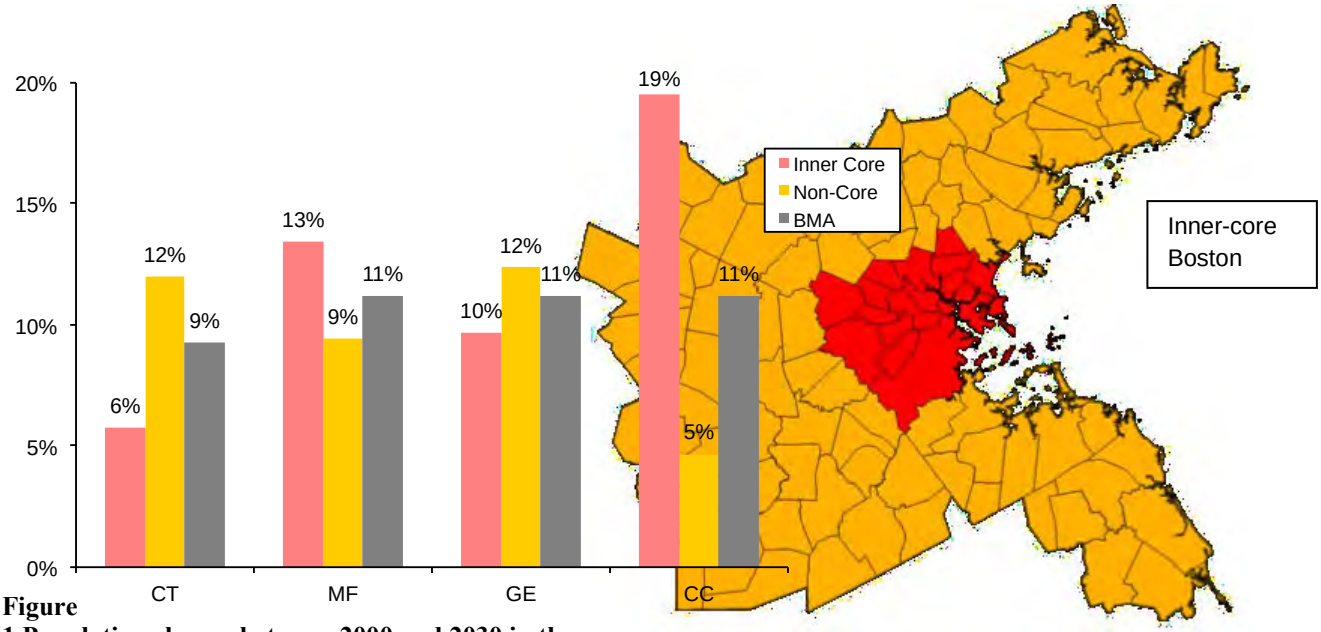

Figure 1.Population change between 2000 and 2030 in the inner core and non-core communities

Results

One of the research questions was whether the inner-core cities including Boston would have enough room to fit the high density projected land use change associated with this population growth. The changes in land use type (Figure 2) show that under the Current Trends scenario, only about 10% of the planning units would need to accept infill development to accommodate the modest increase in population, while over 25% of planning units in the Compact Core scenario would have increased density.

We were also interested in whether there would be trade-offs between densification of the inner core areas and urban greening, especially in the form of tree canopy. However, the trade-offs may not be straightforward. One could imagine a high-density infill project that minimizes the building footprint and increases tree plantings. However, due to the complexity of the scenario modeling, the tree canopy part of the study was limited to the City of Boston and inner core cities. The tree canopy study (described in detail in Danford et al., in review) used population change to determine the negative impacts of increased density on existing tree canopy. The study then looked at tree planting potential in pervious areas, impervious areas (i.e., parking lots); and along streets to determine the ability to "green" urban neighborhoods in Boston.

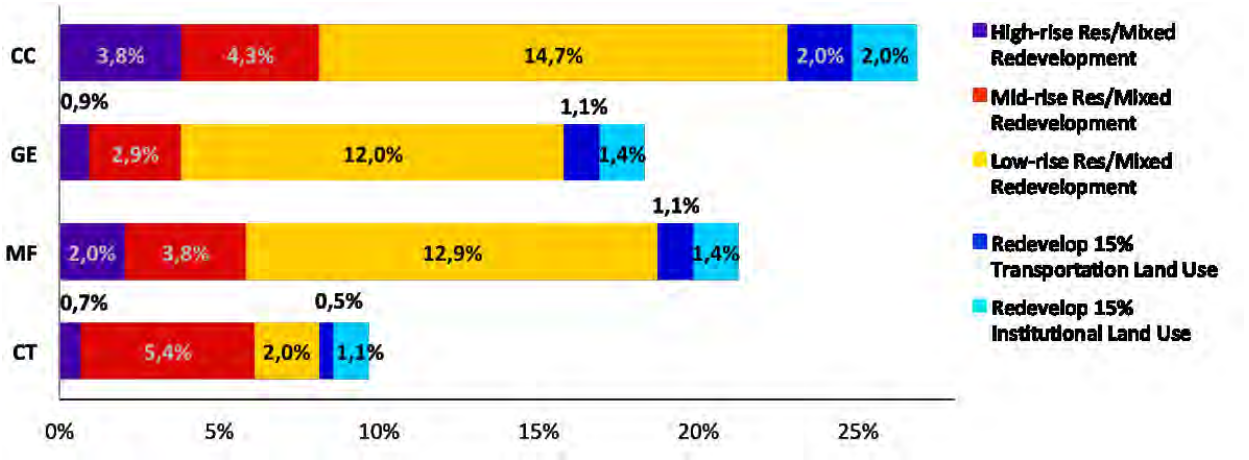

Figure 2. Changes to urban form in Boston under the four scenarios, shown as percentage of subunits (TAZs) projected to receive each type of development

Currently, tree canopies range from under 10% to over 75% canopy cover between Boston neighborhoods. In particular, this study was interested in understanding if focusing tree planting in under-served neighborhoods could overcome the inequities in tree canopy based upon income. The study allocated the tree canopy differently for each scenario. For example, the MetroFuture plan focused tree planting in the new higher density infill areas (greater than 13,000 people per sq. mi.), while the Green Equity scenario focused tree plantings in low-income neighborhoods.

The preliminary results indicate that it is difficult to achieve some of the desired outcomes identified by stakeholders, such as social equity with respect to urban tree canopy (Figure 3 & 4). For example, even increasing tree canopy in all potential areas, did not significantly bring many environmental justice neighborhoods up to the city-wide average in tree canopy of 25% (Danford et al. under review). Thus, there may be a need for more aggressive greening efforts that occur as part of redevelopment as land uses change or buildings are actually removed.

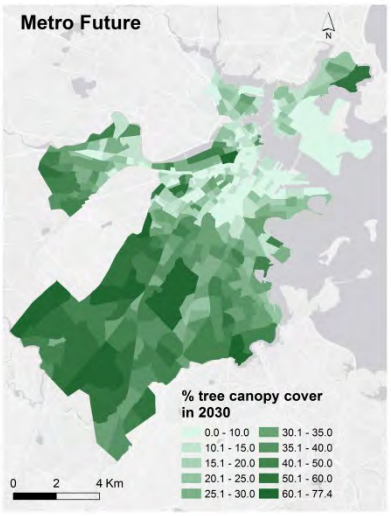

Figure 3. Projected tree canopy in Boston for MetroFuture Scenario in 2030

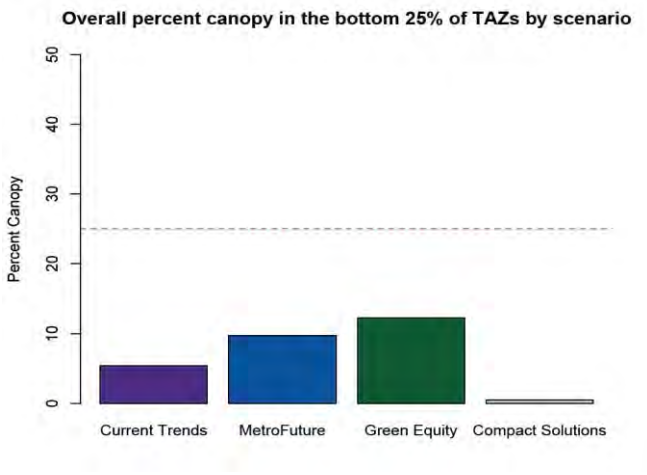

Figure 4. Even the Green Equity scenario which targets low income and minority neighborhoods did not bring the least treed neighborhoods up to the city-wide average.

We were also interested in applying some of the research team's studies of biodiversity to the scenario efforts. Our initial studies in Boston, previous to conducting the scenarios, found that bird diversity increases even with small amounts of additional green space, but suggests that this effect is more pronounced when the new green space is contiguous with existing green spaces (Strohbach et al, 2013) (Figure 5). Applying this to the scenario results to date suggests that efforts to promote urban biodiversity should focus on expanding tree canopy around existing green spaces. However, our tree canopy research suggests that this strategy would further exacerbate the existing socio-economic inequities between lower-income neighborhood with fewer trees and high-income areas that are already very green.

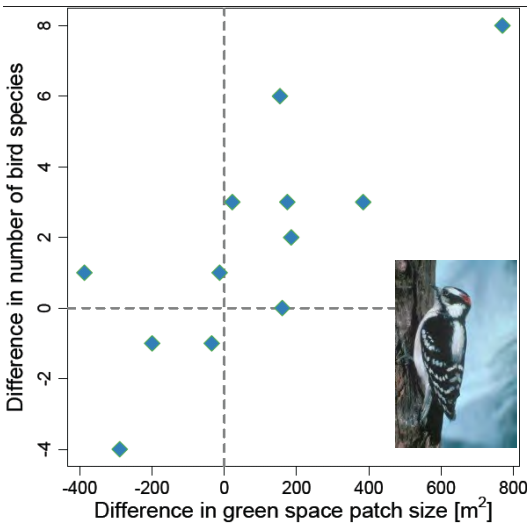

Figure 5. Bird diversity increases with patch size, suggesting that biodiversity would most benefit by planting trees near existing green spaces, rather than distributing them evenly across the city as the Green Equity scenario would do

Stakeholder feedback during the planning workshops highlighted four important areas for further study and refinement of our scenarios. First, since our initial analysis focused primarily on the City of Boston, stakeholders were interested in knowing the regional implications of the scenarios. The team is currently working at the regional scale, particularly with regards to the relationship between land use change and water quality. Second, stakeholders were interested in learning more about the implications of other green infrastructure techniques besides tree canopy, especially those related to stormwater management. Third, stakeholders wanted to the discussion of equity to include more than lack of green space. According to them, jobs and employment are a major issue for improving lower-income neighborhoods that needs to accompany greening efforts. Finally, stakeholders were very interested in quantifying the impacts of the different scenarios. In particular, quantifying the economic impacts of the ecosystem services provided by urban greening and/or open space protection was seen as vital to convince stakeholders and government officials in the region about the efficacy of continued government investment in green space and greening projects.

Implications for Scenario Planning

This research study can offer several insights for landscape planners who are engaged in scenario planning. We found that engaging stakeholders in the scenario planning process allowed us to add a much needed "reality check." The stakeholders pointed out relevant areas of interest, questioned assumptions that were being made, and were keenly interested that the final scenarios were realistic and addressed the unique characteristics and settings found within the Boston region. We also found that converting proposed population changes to actual land-use and land cover change to be more challenging than expected. In an existing highly developed city such as Boston, increasing density requires infill of new development within either existing neighborhoods or redevelopment of commercial and old industrial land. We had to develop our own set of rules and guidelines for infill based on densities that already occur within Boston. Future landscape planning efforts could benefit from having standardized infill development

models to help replicate scenarios across a larger region. Working with stakeholders to determine realistic infill densities and appropriate land-uses to change is an important part of the process. In summary, scenarios are very useful for landscape planners to help their communities articulate a vision for a more sustainable future that increases urban green space while accommodating the need of growing urban populations.

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References

Albrechts, L. 2005. Creativity as a drive for change. *Planning Theory, 4*(3), 247-269.

Danford, R., Cheng, C., Strohbach, M., Ryan, R.L., Nicolson, C., Warren, P.S. (in review). What does it take to achieve equitable urban tree canopy distribution? A Boston case study. *Cities and the Environment.*

Fábos, J.G. 2004. Greenway planning in the United States: Its origins and a recent case study. *Landscape and Urban Planning* 68 (2-3): 321-342.

Gunder, M. 2008. Ideologies of certainty in a risky reality: Beyond the hauntology of planning. *Planning Theory, 7*(2), 186-206.

Klosterman, R. E. 2007. Deliberating about the future. In *Engaging the Future: Forecasts, Scenarios, Plans, and Projects*. Eds. Hopkins, L. D. and M. A. Zapata. Cambridge, Mass., Lincoln Institute of Land Policy. 199-219.

MAPC. 2012. Metropolitan Area Planning Commission. Calendar and annual report page. Available at www.mapc.org.

MetroFuture. 2009. Website: metrofuture.org, accessed January 2010.

Myers, D. and A. Kitsuse. 2000. Constructing the future in planning: A survey of theories and tools. *J. of Plann. Ed. and Res.,* 19(3), 221-231.

Peterson, G. D., Cumming, G. S., Carpenter, S. R. (2003). Scenario planning: A tool for conservation in an uncertain world. *Cons. Bio., 17*(2), 358.

Shearer, A. W. 2005. Approaching scenario-based studies: three perceptions about the future and considerations for landscape planning, *Environment and Planning B: Planning and Design* 32: 67-87.

Steinitz, C., M. Flaxman, D. Mouat, H. Arias, T. Goode, R. Peiser, S. Bassett, T. Maddock III, and A. Shearer. 2003. *Alternative futures for changing landscapes: the Upper San Pedro River Basin in Arizona and Sonora.* Washington, DC: Island Press.

Strohbach, M.W., Lerman, S.B., Warren, P.S. 2013. Are small greening areas enhancing bird diversity? Insights from community-driven greening projects in Boston. *Landscape and Urban Planning 114,* 69-79.

U.S. Census Bureau. 2010. *Census of Population and Housing.* Washington, DC: U.S. Dept. of Commerce, Economics and Statistics Administration, U.S. Census Bureau.