EVALUATING THE OUTCOMES OF NEIGHBORHOOD URBAN FORESTRY

THEORETICAL CONTEXT

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Literature from a variety of disciplines is important to understanding the theoretical basis of our proposed research: (1) tree growth and survival literature; (2) existing research on social benefits of tree planting and urban greening; (3) theory on collective action, social capital, and the co-production of urban services; and (4) literature on climate change and adaptive capacity in cities and the role of trees and tree planting in mitigation and adaptation.

Box 1. Definitions of key terms from the social sciences in the context of our research.

<u>Adaptive capacity:</u> the ability of a community to respond to and manage change or disturbances, both exogenous and endogenous; highly linked to trust and reciprocity, and the strength of relationships between individuals (Adger 2003); an example is neighbors deciding to build a small cooling shelter in a neighborhood park to cope with the increasing frequency and magnitude of extreme heat events as a result of climate change.

<u>Collective action:</u> actions undertaken by a collective, or group, toward some sort of mutually- or jointly-beneficial outcome (Adger 2003; Ostrom 2005; Ostrom 2009b); examples include a neighborhood working together to create a crime watch group that provides public safety services to the neighborhood, or a neighborhood association organizing on a Saturday to water all the newly planted street trees on their block.

<u>Coproduction:</u> provision or maintenance of a public good or service when contributions by more than one group (often sectors, such as nonprofit, private and/or public) are necessary to achieving an optimal outcome (Marschall 2004; Ostrom 1996); an example is the provision of the urban forest by tree-planting nonprofit organizations, individual citizens, and the municipality.

<u>Civic ecology activities:</u> efforts undertaken by individual residents to improve the natural urban environment that have human health and well-being benefits as well (; examples can range from activities as simple as raking the yard or planting a tree to constructing a neighborhood pocket park.

<u>Civic engagement:</u> Participation in discussion and/or addressing issues of general public concern; also called *citizen participation*; examples include voting or participating in an election, joining a parent-teacher association or crime watch group, discussing community health issues with a neighbor.

<u>Direct effects:</u> impacts or outcomes of a program or activity that result from the activity that occurs; for instance, a probable direct effect of tree planting programs is a tree planted in the ground that survives and grows.

<u>Indirect effects:</u> Impacts or outcomes of a program or activity on aspect other than those that the program or activity directly influences; for instance, urban tree-planting programs physically plant trees, but byproducts of this tree-planting may include effects on the community or individuals beyond those conveyed by the physical act of planting a tree.

<u>Institutions:</u> rules, norms, and strategies that constrain human behaviors (Ostrom 2005); examples in the urban ecology setting include municipal laws concerning yard and lawn upkeep, norms of tree pruning or shrub aesthetics, and property rights that constrain the activities of individuals on public and private property.

<u>Social capital:</u> networks of relationships and interactions between individuals or between groups of individuals that enable fulfillment of daily human physical and emotional needs; *bonding* social capital refers to the strength of ties between individuals within groups; *bridging* or *networking* social capital refers to the strength of bonds across different groups (Adger 2003; Putnam 2000).

<u>Social-ecological system (SES):</u> a system in which human (social) and natural (ecological) components are highly interrelated and operate inseparably from one another, thus, the dynamics of the system cannot be separated into an analysis of its component parts; the *SES framework* (Ostrom 2009a) is a method for describing the interactions between the many variables within each of the three components of the SES: biophysical environment, community characteristics, and institutions.

Tree Growth and Survival

Most research on tree success in urban areas has focused on factors related to mortality or survival rates (e.g., Lu et al 2010, Nowak et al 2004, Thompson et al. 2004), while fewer studies have also considered growth rates. Existing research on urban tree growth has generally been reductive in approach: studies either focus on the impact of individual biotic and abiotic (biophysical) factors, while ignoring management or social factors (e.g., soil properties: Grabosky & Gilman 2004, Jim 1998; microclimate: Kjelgren & Clark 1992; water relations: Whitlow et al 1992, Graves 1994, Close et al 1996; and, restricted rooting space: Cermak et al 2000, Grabosky & Gilman 2004, Kopinga 1991), or focus on the impacts of certain types of management regimes on urban trees while controlling biophysical constraints (e.g., pruning: Fini & Ferrini 2011; compaction remediation: Day et al 1995; soil amendments: Gilman 2004; and transplant practices: Neal & Whitlow 1997, Watson 2005). Additionally, many of these studies have been conducted in 'laboratory' settings as true experiments, rather than as natural experiments in the urban environment. Exceedingly few studies attempt to comprehensively measure the combined effects of biophysical and management factors on tree success, much less combine social and community characteristics with these biophysical factors. One exception is the recent study by Lu et al (2010) of the influence of local biophysical factors (urban design, biological condition, etc.) and social factors (e.g., a weeded tree plot as evidence of tree stewardship) on the mortality rates of young street trees in New York City. This study suggests the importance of future research in urban social-ecological systems for understanding the full picture. Apart from this recent endeavor, few studies have attempted to fully capture the social, biophysical and management factors influencing tree success across multiple cities, as our research proposes.

Social Benefits of Tree Planting and Urban Greening

While existing tree success research may be reductive, the indirect effects of tree-planting programs are even less explored. Sommer et al (1994a,b) have evaluated the "user satisfaction" with trees planted in residential yards. They found that residents who planted their own tree were more satisfied with the outcome than residents whose tree was planted by outside parties (Sommer et al 1994a), and that residents who engaged in group plantings were more satisfied with the outcome than residents who planted a tree by themselves (Sommer et al 1994b). This same research group has also measured the attitudes of tree-planting program participants and non-participants toward trees and neighborhoods. Summit and Sommer (1998) revealed that participants were more satisfied with tree location, staking, maintenance quality, and neighborhood quality than non-participants in tree-planting programs. Outside of and since this research group, no systematic, quantitative research has been done to evaluate urban tree-planting programs from a social perspective. Elmendorf (2008) cites an extensive literature from urban planning and community development research, outlining the theoretical linkages between trees, tree planting and community capacity building; yet, to our knowledge, no studies have explicitly analyzed the effects of tree-planting programs on community adaptive capacity or collective action.

A related field of research concerns social and institutional motivations for urban greening efforts. Grove et al (2006), for instance, used remote sensing methods to compare social characteristics with vegetation structure in Baltimore, as part of the Baltimore Ecosystem Study. Additional research in this field has examined community and private gardens and lawn care. Larson et al (2009) examined lawn management in Phoenix, Arizona, to understand how social and cultural norms or legacies impact urban landscapes. According to Robbins and Sharpe (2003), upholding aesthetic norms, the fear of neighborhood sanctions, and property values are key drivers to understanding front yard maintenance. While not directly related to tree growth or survival, this field can inform the social and institutional variables that will be analyzed in the proposed research.

Collective Action, Social Capital and Co-Production

Compared to theories of urban vegetation distribution and provision, theories of collective action in the provision of conventional urban services (e.g., policing, education) are much more developed. Collective action (see Box

A1) has been linked to the existence of both bonding (within-group) and bridging (across-groups) social capital (Adger 2003, Ostrom 1996). Social capital, as a measure of the strength and networks of interactions between people, involves trust and reciprocity (Adger 2003), elements that are also key to successful collective action (Ostrom 1996). Collective action and social capital are important concepts in understanding situations behind coproduction of urban services (Ostrom 2009b, 1996, Adger 2003, Marschall 2004). For instance, studies by Ostrom and colleagues in the 1960s on urban policing demonstrated that citizen involvement in the provision of policing services yielded enhanced delivery of services (cited in Ostrom 2009b). Marschall (2004) looks at citizen awareness of and participation in the coproduction of public safety and schooling efforts and finds that participation in these activities is related to involvement in both formal and informal associations (collective action). This literature indicates reason to suspect that participation in tree-planting activities may have effects on other types of civic engagement.

Climate Change, Adaptive Capacity and Tree Planting

Collective action, social capital and the trust and reciprocity required therein are also critical to a community's adaptive capacity. Adger (2003) argues that adaptive capacity can make a community more capable of coping with the potential change and uncertainty posed by climate change as well as adapting to other adverse circumstances. In marginalized communities in particular, argues Adger (2003), where the established social order results in inadequate provision of public goods and services, social capital can be particularly crucial and can substitute where the state fails. Tree planting, as a type of collective action, may offer an opportunity for the strengthening of bonding social capital as well as the creation of bridging social capital, which could help endow a marginalized and underserved community with the capacity needed to improve the neighborhood through crime protection efforts or mitigate local urban heat island impacts and improve environmental quality through creation of pocket parks. Given that urban tree canopy cover is already inequitably distributed in urban areas, with less canopy cover over low-income neighborhoods (Heynen et al 2006, Wilson & Lindsey 2009), tree-planting activities in marginalized areas therefore have the dual benefits of increasing canopy cover while potentially building social capital and adaptive capacity. Our research will enable analysis of this potential of urban tree-planting programs across multiple cities in the USA.

In addition to the collective action potential of participation in tree-planting project, urban trees can have a direct impact on how neighborhoods experience climate change, through mitigation of the urban heat island effect via shading and evapotranspiration (EPA 2008). Trees can also help manage water quality and stormwater runoff (Nowak 2006) resulting from unpredictable, more severe precipitation events associated with climate change (Allen and Soden 2008). Many urban areas have already undergone changes in climate similar to that projected for the world at large in the 21st century, with increases of nearly 5° C in minimum average daily temperatures in some cities (Akbari et al 2001). Planting trees to shade streets and buildings can reduce air temperatures by up to 2° C (Kurn et al 1994), increasing the capacity of urban residents to withstand extreme heat events, which are predicted to increase in frequency and magnitude in cities as climate change occurs (Stone et al 2010).

On a larger scale, the plant hardiness zones created for trees by the Arbor Day Foundation have migrated northward, altering the planting recommendations for many US cities (http://www.arborday.org/media/mapchanges.cfm). These trends are likely to continue as anthropogenic climate change unfolds over time. The urban heat island places cities well ahead of the climate change curve for their surrounding areas in terms of average temperatures (Stone et al 2010). This may provide an opportunity for the urban forest to serve as a seed bank and source of colonizing trees for the surrounding area, in effect speeding tree migration; indeed this may already be occuring (Woodall et al 2010). Thus, the establishment and analysis of a dataset spanning multiple cities and years for the success of newly planted trees has the potential to help researchers and practitioners alike to understand the impact of climate change not just on urban forests, but potentially rural forests as well.

Our Research

The research proposed here attempts to build on the aforementioned studies through the lens of social-ecological systems research, which examines the interactions and outcomes of human society, our institutions (rules, norms and strategies that guide human behavior [Ostrom 2005]), and the biophysical world (Ostrom 2009a). Urban forests are social-ecological systems composed of biophysical components (trees and associated vegetation) and social components (individuals, households, neighborhoods, and governments, and their subsequent institutions, i.e., property rights and jurisdictions). Thus, like other social-ecological systems, urban forests are complex and adaptive, involving multiple subsystems (i.e., parks, street trees) as well as being embedded in larger systems (i.e., the regional landscape). To understand success and sustainability in these systems requires interdisciplinary and integrated modes of inquiry (Holling 1998) and long-term and cross-site analysis that builds on well documented and theoretically sound scholarship (Ostrom 2009a). In other words, we cannot understand what sustains a planted tree and its climate-maintenance functions by simply asking about the nutrients in the soil alone, or by independently inquiring about the social capital of the nearby residents, or by solely questioning the enforcement of tree watering rules. All of these questions must be explored synergistically in analysis of urban tree-planting programs as a social-ecological system; in doing so, we are able to not only address the factors affecting the outcomes of tree planting but to consider the indirect impacts of tree planting on a community and its collective, civic ecology activities.

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