# The social and economic value of cultural ecosystem services provided by urban forests in North America: A review and suggestions for future research

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## ARTICLE INFO

## ABSTRACT

With the majority of the world's human population now living in cities, urban forests provide an increasingly important range of ecosystem services, from improved air quality and climate change adaptation to better public health outcomes and increased tourism revenues. The importance of these ecosystem services in urban environments, and the central role that cities play in the lives of people around the world, have motivated various attempts to quantify the value of ecosystem services provided by urban forests. This paper reviews existing research in the fields of urban forestry, economics, sociology, and health on the value of urban ecosystem services, with a focus on cultural services, a category of ecosystem services that is of key importance to human well-being but that has suffered from a lack of empirical research. The review identified 38 studies that examined the value of mixed vegetation, 31 studies that examined the value of trees, and 43 studies that examined the value of green spaces. Psychological health is the most-studied ecosystem service category, with most research in this area focusing on the services of mixed vegetation. Social health, community economic development, and tourism are the least-studied, with most research in these areas focusing on mixed vegetation and trees. Multiple metrics were used to quantify the value of urban greenery within each ecosystem service category but only 11 metrics were assigned a monetary value. Gaps in the literature that present strong opportunities for future research include: the value of urban forests for improving social health, equitable access to ecosystem services, the impact of urban forests on community economic development, and economic valuation and green exposure metrics. We hope that this review stimulates future research in the areas highlighted and that municipalities consider including evaluations of a broad range of ecosystem services during land use planning and budgeting processes.

## 1. Introduction

Cities are where billions of us live – and cities are growing. They are social, financial and educational centres that attract increasing numbers of residents around the world. This trend towards urbanization is particularly strong in Canada and the United States of America (U.S.), where approximately 80 percent of the population now lives in urban areas (McPhearson et al., 2013). As cities grow, urban forests can play a role in maintaining quality of life for urban residents by providing various ecosystem services, including improving the urban environment (Goddard et al., 2009; Gómez-Baggethun and Barton, 2013; Landry and Chakraborty, 2009; Morimoto, 2011; Savard et al., 2000); supporting good physical, mental, and social health (de Vries et al., 2003; Groenewegen et al., 2006; Hartig, 2008; Maas et al., 2006; Mitchell and Popham, 2008, 2007); and providing economic benefits (Anderson and Cordell, 1988, 1985; Morales, 1980; Payne and Strom, 1975; Schroeder, 1989; Wolf, 2009). To maximize these benefits through urban forest planning and management, the costs and benefits of urban forests must be understood and managed by urban planners, city managers and decision makers, and even private citizens, during land use planning and city building processes (Livesley et al., 2016; Vandermeulen et al., 2011). Urban forest planning and management is most effective when the services and costs of urban forests are understood and can be compared directly with other city infrastructure and services during budget analysis and priority setting (Jim and Chen, 2008). Urban foresters, planners, academics, communities, and governments all have opportunities to create liveable environments that promote environmental sustainability, human health, and economic productivity.

In recent years, the public and various levels of government in

Canada and the U.S. have become increasingly aware of the importance of urban forests and the benefits they provide, leading to renewed investment in urban forests by municipalities such as Phoenix (City of Phoenix, 2009; Harnik, 2010), Toronto (City of Toronto Parks, Forestry and Recreation, Urban Forestry, 2013), and Vancouver (City of Vancouver et al., 2014; Poudyal et al., 2009). As cities and other levels of government invest in urban forests in Canada and the U.S., they will need guidance on how to evaluate the benefits and costs of urban forests to prioritize urban forest investments.

While much work has been done to quantify some of the values of urban forests in North America, evaluations to date tend to focus on regulating services such as microclimatic improvements and carbon sequestration (Alexander and DePratto, 2014; Alexander and McDonald, 2014; McPherson et al., 1997; Nowak, 1994). The benefits of urban forests are more complex and wide-ranging than suggested by evaluations completed to date (Livesley et al., 2016). This paper goes beyond previous assessments to present a review and synthesis of relevant and accessible research on valuing the cultural ecosystem services of urban forests, an emerging area of ecosystem services research that is of key importance to human well-being in cities (Livesley et al., 2016; Wolf et al., 2015). It is the authors' hope that this review will expand the understanding of the value of urban forest services and support including the full range of urban forest values in urban forest planning and management.

It is important to note that this review does not seek to measure the costs of managing and maintaining urban forests. These costs are highly context-specific and will vary by municipality and region. Rather, this paper focuses on the value of urban forest services and highlights knowledge gaps in how to evaluate these services. By clarifying the evaluation of services, this analysis highlights areas for further research and may help municipalities include such evaluations during their own management planning and budgeting processes.

## 2. Methods

### 2.1. Ecosystem services

Within the context of urban forests, the term "ecosystem services" refers to the benefits provided to humans through functional processes and interactions with the surrounding environment and local ecology (Livesley et al., 2016). Urban forest ecosystem services are highly interrelated. For example, access to urban green space can provide recreation opportunities, which in turn can provide physical health benefits and increased social cohesion (Konijnendijk et al., 2013). Despite this interrelation, ecosystem services are now commonly organized into four broad categories, supporting, provisioning, regulating, and cultural, to facilitate clear discussion and analysis (Alcamo et al., 2003). Our review and analysis uses the ecosystem services framework set out in the Millennium Ecosystem Assessment (Alcamo et al., 2003), focusing on cultural ecosystem services, a category of ecosystem services which is closely associated with liveability and human well-being in urban environments (Jansson, 2013; Wolf et al., 2015). However, cultural ecosystem services are poorly defined, particularly in the field of urban forestry (Chan et al., 2012; Satz et al., 2013). For the purposes of this review, we expand the definition of cultural ecosystem services offered by the Millennium Ecosystem Assessment to include "the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" (Alcamo et al., 2003, pp. 58) and economic benefits people obtain from non-consumptive use of ecosystems, for example as a result of their aesthetic qualities or recreational desirability.

### 2.2. Study screening

This review focuses on the North American urban forestry and city

planning context, but also includes key examples of valuations and metrics from international studies. Research was selected for inclusion in the review using a systematic and iterative screening protocol that was developed by the authors. Articles were collected and collated using keyword searches across a variety of databases and search engines (e.g.; Google Scholar; Web of Science; PubMed; JSTOR); review of tables of contents of key journals; and 'snowballing' from citations within collected articles (Konijnendijk et al., 2013; Wolf et al., 2015). Articles were selected; evaluated; and culled based on the following criteria: (1) reporting on an original scientific study or reviewing and summarizing reports of original scientific study; (2) presenting economic valuation methods or other systems to measure the non-monetary value of ecosystem services in the urban context; (3) representing studies on urban environments in North America or key research from international urban environments where North American studies were not available; and (4) valuing ecosystem services in the cultural services category. This system ensured that our review considered the best studies of appropriate scientific rigour. Periodic consultations among the authors on whether to include a study generated a final list by consensus of 91 studies; including 87 peer-reviewed articles and 4 studies published in books, professional reports, and professional magazines. The review is current to the year 2016.

## 3. Results

Urban residents experience a wide range of cultural ecosystem services provided by urban greenery. Cultural ecosystem services include some more measurable services such as health outcomes and direct economic benefits, while other cultural ecosystem services are more intangible and experiential, such as spiritual experiences, education, and aesthetics. The nature of cultural ecosystem services makes them difficult to define and measure; valuing cultural ecosystem services is still an emerging area of research and the published research defines urban greenery in multiple ways and uses multiple metrics to determine its value.

The present review identified 38 studies that examined the services of mixed vegetation (i.e., multiple or unspecified types of vegetation), 31 studies that examined the services of trees, and 43 studies that examined the services of green spaces (generally defined as parks, woodlands, or agricultural areas). Studies that examined more than one type of greenery were counted in each category. Psychological health is the most-studied ecosystem service category, with most research in this area focusing on the services of mixed vegetation (Table 1). Tourism, community economic development, and social health are the least-studied, with most research in these areas focusing on mixed vegetation and trees. Multiple (32) metrics were used to quantify the value of urban greenery but only 11 metrics were assigned a monetary value (Table 2).

**Table 1**

Total number of studies included in the review per ecosystem service category and by type of urban vegetation. When a study addressed more than one type of vegetation it was counted once in each type of vegetation and once in the total for that service category. Some studies addressed more than one service category and were counted in each service category they addressed.

| Ecosystem service category | Type of urban vegetation | | | Total studies |
|---|---|---|---|---|
| | Mixed vegetation | Trees | Green spaces | |
| Physical health | 10 | 4 | 9 | 16 |
| Psychological health | 19 | 6 | 12 | 30 |
| Social health | 6 | 0 | 3 | 9 |
| Property values | 0 | 14 | 14 | 28 |
| Community economic development | 1 | 5 | 2 | 6 |
| Tourism | 2 | 2 | 3 | 4 |