Matthew Wells Supporting Paper
Street Tree Seminar (01/17/2019)

Sustainable Urban Forest Management: Turning Rhetoric into Reality

Introduction to Sustainability and Sustainable Urban Forest Management

The idea of sustainability is closely linked with the historical forestry practice of 'sustained yield' (Finn, 2009). The guiding principle is that there is a balance between harvesting and planting. The United Nations World Commission on Environment and Development report (1987), entitled *Our Common Future* provided a popular definition of sustainable development:

'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'

Sustainability is about improving the lives of both current, and future populations. The guiding principle of sustainable development is to plan and build a strong economy, alongside healthy and functioning communities. Ideally, the environment is diverse, safe and able to adapt to climate change. The phrase, 'Think globally, act locally and plan regionally' is an established philosophy of sustainability (Chang and Huang, 2004). The concept of sustainability, particularly due to its philosophical link, can be applied to all types of forestry. One widely accepted definition of sustainable forest management (SFM) comes from the United Nations stating it is a:

***"Dynamic and evolving concept [that] aims to maintain and enhance the economic, social and environmental values of all types of forests, for the benefit of present and future generations"* (FAO United Nations, 2016).**

This definition of SFM is clearly applicable to the management of urban forests. Though a desired outcome for many programs, the challenge comes in delivering on this concept by using data, research and measurable metrics. Policies of 49 Californian municipalities were accessed, 82% indicated that species diversity was an objective but only 48% had codified this in a management plan (Muller and Bornstein, 2010). This type of scenario is most likely common. Therefore, how does the rhetoric of SFM become a reality for a City's management of its urban forest resource.

Urban Forests can be a Tool of Sustainability

An urban forest can be a valuable sustainability-planning tool because of the wide range of economic, environmental and social benefits it provides. The social and psychological benefits have been proven in numerous research studies (Kapland & Kapland,1989; Kou et al,1998; Ulrich, 1984). The economic and environmental benefits they provide can be qualified and quantified using tools like i-Tree (USFS, 2014; FC, 2010; Kling, 2008). PlaNYC, the sustainability plan for New York City, used trees in multiple policy areas because of the diverse and significant benefits they provide. The City utilized i-Tree data to understand how trees could be used to help achieve sustainability goals in managing storm water management, reducing energy use and reducing air pollution (Wells, 2011). It should be noted that trees are significantly less expensive than many other techniques used in mitigating the negative aspects of urbanization.

A valuable summary of the sustainable benefits of trees from the UK Forestry Commission (2010) is provided in **Appendix 1.** Additionally**, Figure 1** illustrates how trees contribute more benefits as they grow and develop (USFS, 2014). Therefore, preserving existing trees and planting additional large canopied trees is desirable. However, tree species and location must be carefully considered so they do not become unsustainable to maintain. Trees can cause direct, or indirect infrastructure

damage to structures (Biddle, 1998), or require high maintenance. Poorly placed trees can increase energy consumption (USFS, 2014) by shading properties. They can also detract from a resident's enjoyment if they overpower the landscape, drop excessive fruit or pose a perceived risk.

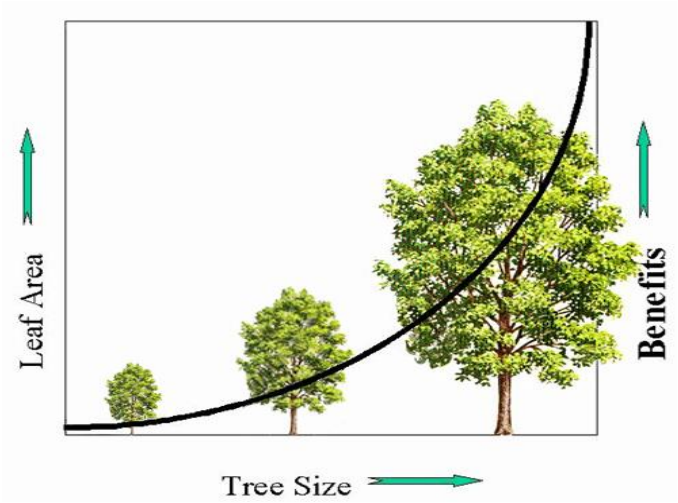

Figure 1. Diagram illustrating the relationship between benefits and tree size (USFS, 2014)

Sustainable Management of the Urban Forest

Though a powerful tool of sustainability, the urban forest must be carefully managed so it can deliver these ecosystem services for perpetuity. A recent study by the U.S. Forest Service (Nowak and Greenfield, 2012) found that 17 out of 20 U.S. cities analyzed had significant declines in urban tree canopy (UTC) cover. In this study UTC declined by an average of just over a quarter of a percent per year. This decline is likely due to increasing urbanization, population growth and through other stressors such as climate change.

However, proactive urban forestry programs can help combat and communicate this decline to policy makers and the community, through strategic and systematic resource management coupled with performance metrics. The City of Santa Monica (CSM) has recently adopted six urban forest sustainability metrics in its

recently updated Urban Forest Master Plan (CSM, 2017). These metrics are described in **Figure 2**. below:

Figure 2. Image depicting the six urban forest sustainability metrics adopted by the City of Santa Monica (2017) in their Urban Forest Master Plan.

These metrics cover key indicators of the physical attributes of Santa Monica's public urban forest resource as well as its function. These metrics are measured on a specified timeframe that differs dependent upon the element being measured. These metrics will be described in detail in the next section.

City of Santa Monica Urban Forest Sustainability Metrics

Santa Monica is a coastal city in Southern California that covers approximately eight square miles. The City has a publically owned urban forest that consists of approximately 33,500 street and park trees (CSM, 2017). The urban forest

sustainability metrics described below are applied to the resource in it entirety due to the City's relatively small geographical size.

1. Annual metrics

1a: Net Tree Gain or Loss

This is perhaps the most basic of all urban forest sustainability metrics. Measured on an annual basis, it simply reports on how many trees were planted versus how many were removed. Though limited in its usefulness as the size of the tree removed is not accounted for, it does give an indication if tree planting is at a sufficient level to provide for a healthy renewal of the urban forest.

1b: Species Diversity

A species diverse urban forest is favorable as it adds resilience to climate change and pathogen attack. **Table 1** presents a summary some of the most common industry recognized species diversity recommendations.

Authors	Species Diversity Recommendations
Miller and Miller (1991)	No species shall exceed 10% of the population
Kielbaso (1989)	No species should exceed 5% and no genus should exceed 10%
Santamour (2002)	Plant no more than 10% of any species, no more than 20% of any genus and no more than 30% of any family

Table 1. A summary of some of most common species diversity recommendations

Santa Monica has adopted a desired diversity goal which is that no species will exceed 5% and no genus will exceed 10% (CSM, 2017). As the City assigns species at a planting space level it is able to project forward species percentages in the future. This therefore guarantees that the diversity goal is planned for and therefore achieved.

1c: Street Tree Stocking

Street tree stocking level in many ways is an extension of net tree gain or loss (1a). It is the percentage of actual street trees versus potential street trees. Obviously a comprehensive database of existing street trees and vacancies (empty planting spaces) is needed to calculate this metric though modeling can be used. Santa Monica had approximately 96% stocking in 2001 that has now dropped to 93% in 2016 (CSM, 2017) with over 2000 street tree vacancies. Understanding this metric and the geographical location of these vacancies allows for decisions to be made both on resource levels and also on planting prioritization. Santa Monica uses GIS modeling to take account of urban forest resource metrics coupled with human and environmental need to create a five- year street tree planting prioritization plan so the City can aim to reach 100% street tree stocking (CSM, 2017).

2. Five-year Metrics

2a. Young Tree Mortality

Young tree mortality is a useful indicator of the success or failure of an urban forest renewal program. The failure for young trees to establish after a capital investment in planting can quickly become a significant political issue as well as lead to the eventual demise of the urban forest resource.

A study of young street trees in New York City found from a sample of trees that had been in the ground between three and nine years, only 74% were still alive (Lu et al., 2010). Another study of newly planted trees in Liverpool, found that 23% had died three years after planting (Gilbertson and Bradshaw, 1990). Roman et al. (2014) assessed young trees distributed to residents in California and found a survival rate of 74.5% after one year in the ground that had dropped to 58.9% after five years.

In 2014 Santa Monica surveyed 500 young trees that had been in the ground from one to five years. Of those trees, approximately 80% were found to be alive and appearing to establish successfully. This is significant as it shows that Santa Monica's urban forest renewal program is performing relatively well when compared to available research data. The mortality study will be repeated in 2019 to see if this low level of mortality has continued.

2b. Ecosystem Services

Quantifying the ecosystem services delivered by an urban forest allows for trees to be 'sold' as a sustainability tool to planners, policy makers and the community. In 2001, the ecosystem services delivered by Santa Monica's urban forest was estimated as being $2.5M (McPherson et al., 2001). This value increased to $5.1M in 2015 (McPherson et al., 2015) when re-measured using i-Tree. This knowledge is very valuable as it provides details on the function of the urban forest and allows for an informed decision to be made on cost of the resource versus the benefit it provides. It additionally justifies the enhancement of the resource so greater ecosystem services can be provided, and allows for the urban forest to be included in wider policy plans for the City's aspiration to be a sustainable community.

3. Ten-year metrics: Urban Tree Canopy (UTC)

The City of Santa Monica's UTC was estimated as being 15% in 2001 (McPherson et al., 2001) and an updated UTC assessment will be completed in 2017 (CSM, 2017). A study in NYC discovered that 21% of the City's total land area was covered by UTC though it could potentially be 64% (O'Neill-Dunne, 2012). Following the example of NYC, an assessment of the potential for new UTC by land-use type will be performed in Santa Monica as well as a look back on how UTC has changed. This will allow for an informed decision to be made on the City's UTC and how climate change and urbanization has impacted the resource in recent years. Finally,

understanding the potential for UTC by land-use type will allow for an informed decision to be made on establishing a UTC goal. Currently the City has made the commitment to add 5% UTC to the publically owned urban forest over the next decade (CSM, 2017). This will be achieved through strategic tree planting, updated tree pruning specifications and the creation of new parkland.

Conclusions

The urban forest has a critical role in a sustainable community because of the ecosystem services it provides. Santa Monica, New York, and Malmo in Sweden are good examples of cities using trees to build sustainability into their communities. The concept of sustainability should also be built into the strategic management of the urban forest resource. The identification and tracking of specific metrics over suitable timeframes will provide great insight into the sustainability and function of a City's urban forest so modifications can be made if necessary.

Appendix 1: The Case for Trees Summary (FC, 2010)

Climate change contributions	Countering climate change	• Trees remove CO_2 to create a carbon sink • Trees provide significant low-carbon options for building and energy
	Tempering severe weather	• The capacity of trees to attenuate heavy rains and floodwater slows run-off and renders Sustainable Urban Drainage Systems more effective
	Moderating temperatures	• The ability of trees to evaporate water, reflect sunlight and provide shade combine to cut the 'urban heat-island' effect
Environment advantages	Valuable aesthetic contributions	• More attractive landscape • Eye-sores hidden • Greener more natural • Linking town to country
	Cutting soil erosion	• Preserves the valuable soil resource and keeps carbon locked in
	Positive impact on water quality	• Trees act as natural filters
	Contributing to wildlife	• Increased biodiversity as countryside becomes more porous with extra links • Brings wildlife closer to people
Economic dividends	Providing profitable by-products	• Firewood/woodchip • Compost/leaf litter mulch • Renewable fuel – via coppicing • Timber • Fruit – community orchards
	Reducing greenspace maintenance costs	• Trees are much less maintenance intensive
	Contributing indirectly to local economies	• People more productive • Job satisfaction increased • Jobs created • Inward investment encouraged • Retail areas with trees perform better • Increased property values • Adds tourism and recreational revenue
Social benefits	Delivering a range of health benefits	• Cleaner air means less asthma • Lower risk of skin cancer • Quicker patient recovery times • Reduced stress • Positive impact on mental health and wellbeing • Encourages exercise that can counteract heart disease and Type 2 Diabetes
	Assisting urban living	• Improves buildings' energy efficiency and can help alleviate fuel poverty • Improved protection in winter • Increased pedestrian safety • Baffles noise • Moderated micro-climate • Increased CO_2 absorption • Reduced crime levels
	Adding to social values	• More harmonious environments • Heightened sense of pride in place • Greater community cohesion
	Offering spiritual value	• Heightened self esteem • Puts people more in touch with Nature and the seasons • Symptoms of anxiety, depression and insomnia alleviated
	Benefiting education	• Concentration increases in 'natural' classrooms • Better learning outcomes

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