The Value of an Urban Forest

"The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexity of the land organism. Only those who know the most about it can appreciate how little we know about it. The last word in ignorance is the man who says of an animal or plant: "What good is it?"

Aldo Leopold

What good is a tree or a forest in a city? Or more precisely how much is it worth to the people of the city? In ancient Greece, gods were worshipped in groves of trees and trees were sacred. In Germany the Linden tree was believed to help unearth the truth and judicial meetings were held under a Linden tree. Today, in our industrial forests we value timber based on market prices for cubic meters of lumber, or tons of biomass. In cities, though, we don't grow trees as a marketable product - so how much is a tree worth in a city? Perhaps to someone like Aldo Leopold, we are simply demonstrating our ignorance by trying to quantify the value of a plant, but so often it seems our society is driven by monetary considerations. That means that a decision that requires additional public resources, like planting or caring for a tree, must be justified by an analysis of cost and benefit.

The cost of trees isn't just their planting either. Uncared for trees cause injuries or even deaths – a kind of 'danger cost' no-one wants to pay and that gets a lot of press. Recently, a New York state official stated that "We shouldn't plant new trees until we can guarantee that the existing trees are safe."[1]

To put the danger cost of trees in perspective, let's look at a few statistics. There are 5.2 million trees in New York City (Table 1). Between 2006 and 2011, fifty-one people were injured (2 fatalities)[2]. Hence the statement, "we shouldn't plant new trees." Let's look at some more statistics, though. According to the last census 1.4 million NYC households own cars, roughly 25% of the number of trees in the city. In 2012 alone there were 270 traffic fatalities[3]. That's 270 deaths in a single year – and we haven't heard anyone suggesting that we stop allowing new cars into NYC. Or consider the statistics on lightning fatalities. There are an average of 67 lightning fatalities and 300 injuries per year in NYC[4]. This means a New Yorker is *less* likely to be injured by a tree than they are to be struck by lightning. While tree fatalities get a lot of press, the press attention is disproportionate to the real danger.

On the other hand, decades of scientific research has documented the economic, social and environmental benefits of trees in our cities. Trees can improve air and water quality by removing harmful gases and particulates from the atmosphere[5] and reducing urban runoff

which in turn reduces stormwater treatment costs[6]. People with access to more green space have better mental and physical health[7]. Also trees can help mitigate the urban heat island effect by reducing surface temperatures[8].

Let's look at Table 1, an urban forest summary of New York City from a 2007 report (data collected in 1996) which uses a model called the Urban Forest Effects Model (UFORE) and estimates the aggregate value of all the trees in NYC (http://treesearch.fs.fed.us/pubs/19661). We can quickly see that the 5.2 million trees in the city remove over 2000 tons of pollution per year, providing a value of $10.6 million dollars per year to the city. Also a large amount of carbon is stored

Table 1. Summary table from "New York City's Urban Forest" published in 2007.

New York City Urban Forest Summary	
Feature	Measure
Number of trees	5.2 million
Tree cover	20.9%
Most common species	tree of heaven, black cherry, sweetgum
Percentage of trees < 6-inches diameter	42.7%
Pollution removal	2,202 tons/year ($10.6 million/year)
Carbon storage	1.35 million tons ($24.9 million)
Carbon sequestration	42,300 tons/year ($779,000/year)
Building energy reduction	$11.2 million/year
Avoided carbon emissions	$167,000/year
Structural value	$5.2 billion
Ton – short ton (U.S.) (2,000 lbs)	

or removed from the atmosphere each year. This data was instrumental in allocating funds for planting one million trees in New York City. UFORE estimated that for every dollar invested in planting a single tree, the return to the city in health and other benefits would be $5.60.

Planting a tree in a city is an investment in the future but also represents a commitment to continue to maintain and care for that tree during its lifetime. Understanding all the costs and benefits of that commitment can help city governments and the foresters they employ make informed decisions about how to support that investment and honor the commitment to the newly planted trees and the people enjoying the benefits of additional green space in the city.

It turns out that it's not that trees are good or bad - it's that trees can do a lot of good, good that we want to be able to measure, in order to justify the cost of caring for them so they'll exist and they'll be safe. When we try to put a monetary value to the costs and benefits of establishing or caring for an urban forest we find that some are easier than others to quantify. Planting and maintenance costs are relatively easy to estimate. On the other hand how do you put a value on having better air quality? Scientists with the United States Forest Service have lead the development of a suite of ecosystem service assessment and modeling tools called i-Tree (http://www.itreetools.org/about.php). i-Tree is an updated version of the UFORE model mentioned previously. Like UFORE, i-Tree is designed to provide baseline data on the structure and composition of the urban forest and information on the monetary value of trees to a city and its inhabitants. The i-tree model addresses the complexity of the urban ecosystem using information and data from the scientific community at large.

If the model is that complex is it something that an urban forestry department in a city can undertake and if so how difficult is it to gather the data?

i-Tree has been used in many cities across the U.S. and around the world. Field data is collected from 1/10th acre (404 m^2) circular plots randomly located throughout the city by forestry field crews. This process is not unlike a traditional timber cruise in a forest except you could be working on a plot in a city park, in the middle of a highway or on a tree lined street. If there are trees on the plot they are measured in the traditional way... species, diameter at breast height and total height. In addition if a building is close by the distance and direction from the tree is recorded. Other data unique to the urban environment includes documenting the surface of the ground is like. Is it made up of an impervious surface like a sidewalk or road or is it grass or a garden?

Figure 1. Three hundred randomly located plots measured during the summer of 2013.

Figure 2. i-Tree crew locating plot center from an aerial photograph.

This summer in NYC, we set out to update the 1996 survey using the i-Tree Eco protocol to measure a total of 300 randomly located plots (Figure 1) with a team of four college students. They worked in teams of two throughout the summer and used printed maps to locate plot center (Fig. 2). We had another team conducting validation checks on a subset of the plots the crews had completed to ensure data quality.

Now that we have multiple years of data collected we will be able to analyze trends in New York City's urban forest. Will the fact that over 700,000 trees have been planted in the city since the last survey have a significant impact on what the urban forest looks like now? Or are those trees still too small and will the mature trees lost in extreme weather events like hurricane

Sandy outweigh any gains that have been made by planting? We now have the ability to answer these question and many others.

Meanwhile back in the state of Brandenburg Germany, an area with the second lowest population density in Germany, there were 78 tree related fatalities in 2010. These fatalities, though, were the result of automobiles running into trees. Brandenburg's infrastructure minister was quoted as saying "I cannot and will not live with this fact"[9]. His solution was to reduce the speed limit on tree lined boulevards… a somewhat more measured approach than cutting down all the trees. It wasn't that this official didn't care about the people, he just recognized the value of trees as well. i-Tree is designed to help us justify a more measured approach to trees and their existence in our cities, especially in societies that are often driven by monetary considerations.

Is it really the "last word in ignorance" to show the value of trees in our most densely populated areas so we can continue to make sure that people in our cities can enjoy the positive benefits of trees without having to get in their cars and drive to the wilderness that Aldo Leopold was so passionate about?

[1] http://www.nbcnewyork.com/news/local/Pregnant-Woman-Critically-Injured-by--218303721.html

[2] http://www.nytimes.com/2012/05/14/nyregion/in-new-york-neglected-trees-prove-deadly.html?pagewanted=all

[3] http://www.nytimes.com/2013/03/19/nyregion/more-traffic-fatalities-in-new-york-city-in-2012.html?_r=0

[4] http://www.nyc.gov/html/oem/html/hazards/weather_thunder.shtml

[5] Beckett, K. P., Freer-Smith, P. H., & Taylor, G. (1998). Urban woodlands: their role in reducing the effects of particulate pollution. *Environmental pollution (Barking, Essex : 1987)*, *99*(3), 347–60. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15093299

[6] Dwyer, J., Mcpherson, E. G., Schroeder, H., & Rowntree, R. (1992). Assessing the benefits and costs of the urban forest. *Journal of Arboriculture*, *18*, 227–234.

[7] Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental science & technology*, *44*(10), 3947–55. doi:10.1021/es903183r

[8] Meineke, E. K., Dunn, R. R., Sexton, J. O., & Frank, S. D. (2013). Urban warming drives insect pest abundance on street trees. *PloS one*, *8*(3), e59687. doi:10.1371/journal.pone.0059687

[9] http://www.spiegel.de/international/germany/dangerous-lanes-german-state-aims-to-curb-tree-deaths-a-791840.html