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Letters

The following letter was submitted as feedback to: Sydnor and Subburayalu. 2011. Should we consider expected environmental benefits when planting larger or smaller tree species? Arboriculture & Urban Forestry *37(4):167–172. The author response follows the letter submission.*

To whom it may concern:

There seems to be a growing interest in our industry to set values for the environmental benefits provided by trees and plants. Sydnor and Subburayalu (2011) is another attempt at that paradigm.

I applaud the authors' effort to determine what may or may not have happened in the 46 years between the planting and their study, and also applaud their sincere attempt to select the 10 representative trees from the two planting sites. There are, in my opinion, a few points that may marginalize this article's conclusions.

The adjusted base for this study is the survival rates for hawthorns (*Crataegus* × *lavallei* Hérincq ex. Lavallee) and honeylocusts (*Gleditsia triacanthos* L. Sunburst) planted on two separate streets (Morton Avenue and Orchard Grove Avenue, both located in Brooklyn, Ohio, U.S.). The authors achieve this rate "by dividing the number of surviving trees by the (estimated number)—my emphasis—of possible planting sites in 2007 and 2009. Obvious replacement trees and open sites were counted as missing." One is left to assume that "missing" equals did not survive.

There is no data on why the estimated nine honeylocusts and six hawthorns did not survive, which makes it extremely difficult to evaluate species/site suitability.

There is no data on the soil at the two sites other than that they were different Urban Complexes of a "relatively recent geological origin." Honeylocusts fix nitrogen. One might assume, therefore, this essential growth element to be more available at the Morton Avenue site. Within the 46 growing seasons the hawthorns had reached a height of 7.4 m and the honeylocusts had reached a height of 15.3 m. Trees on both sites were pruned to ensure clearance for roadways and sidewalks. If the trees at both sites were crown raised to equal heights (data not available), then one would assume that the hawthorns were pruned considerably more than the honeylocusts.

At the end of 46 years, the DBH for the hawthorns was 34.5 cm and the honeylocusts 51.5 cm. Comparison of benefits were based on these DBH measurements.

Ten trees from each street were randomly selected, analyzed, and given dollar values for their perceived environmental benefits in five categories (Table 2; Table 3).

In each annual benefit category, the authors conclude that the larger honeylocusts have a greater dollar value than the hawthorns.

In each of the following categories, I submit observations that seem to be in disagreement with the authors' observations, and if correct may alter the values reached by the authors.

Energy Conservation. The authors conclude that properly placed trees will save energy by shading, evapotranspiration, and reducing wind speed. At face value, most would agree that this is accurate. On a global scale, this assertion reverses. While the authors state that their values are "discounted" for biogenic volatile organic compounds (BVOC), there is no reference to a BVOC "the smell of a pine forest," which I assume to mean pinene. All trees release BVOC. Larger trees release higher amounts of BVOC. Trees release BVOC 365 days a year. BVOC emissions, like energy use, fluctuate with environmental conditions. I seriously doubt that the energy saved by the placement of trees near energy-using structures comes anywhere near mitigating the total global BVOC emission that contribute to global warming. But then again, I don't have their discount data.

Air Quality Improvement. The authors state that "air quality savings include reduced ozone, nitrous and sulfur oxides, as well as particulate matter." Actually, BVOC admitted by trees contribute to the formation of tropospheric ozone (smog), which should not be confused with upper level ozone. The allergenicity of trees is well known. The National Institute of Allergy and Infectious Diseases is a good source for this information. Asthma related to tree pollen and particulate matter is rising. The contributions of larger trees verses smaller trees are also well document.

CO_2 Benefits. The stored carbon in this study is listed as 3.5 times greater for the honeylcousts than for hawthorns. All trees die. If they are disposed of similarly, the carbon released back into the atmosphere would be 3.5 times greater for the honeylocusts. The figures will wash. Any benefit would only be temporary.

Stormwater Control. Stormwater interception is only partially based on canopy size and volume. Crown density is significantly different (Figure 1). One would suspect that, by volume, the hawthorns might intercept more stormwater than the lacy honeylocust canopies.

Property Values. There are many ways to place values on property by trees. Some, like the authors, use DHB in their calculations. It is inconsistent with the concept of value to assume that any tree contributes more to a property's value than its individual value. The same tree can both increase and decrease a property's value over time. If, however, a honeylocust delivers 15.6 times greater annual aesthetic benefit than a hawthorn, then it also holds that its loss to the property will be 15.6 times greater than a hawthorn.

I would respectfully like to suggest that the authors did not scientifically validate their conclusion that, "Regardless of how it is viewed here there is a significant reduction in environmental benefits when using smaller statured trees compared with larger trees."

Regards,

Norm Brady
St. Michaels, Maryland, U.S.

Author Response

I am pleased that Mr. Brady noted the increased interest by researchers and practitioners alike in trying to define environmental benefits. One frustration for me over fifty years is that I have often been told that the customer could not afford to plant trees because while everyone knows that trees are attractive, attractiveness cannot be quantified and does not affect site functionality. Both are inaccurate and now we begin to have the tools needed to address these questions. I will try to address some of the questions he raised in no particular order.

Site Conditions. Of the 97 sites originally identified for inclusion in the OSTEP city plantings, these two sites had the least site restrictions and were most similar where both a large and smaller growing tree had been planted. Both sites had large tree lawns (~3 m), similar homes with similar setbacks, similar maintenance guidelines and the same crews, similar socio-economic circumstances, lack of overhead wires, and no canopy trees nearby at planting. Further, no major construction activity resulting in plant losses had been noted since planting. Trees were similar in size at planting. In our judgment, sites were not particularly limiting for urban sites and the resulting growth over 46 years would be representative of the growth of larger and smaller growing trees that might be expected in a desirable urban site in the northeastern U.S.

Survival Rates. Survival rates were based on possible planting sites available in 1964 rather than at the time data was collected. Neither site had seen construction activity. Where present, sidewalk cuts appeared to be the same age as the streets and sidewalks. Curbs had not been replaced in the 46 years since planting. This was based on a site inspection, earlier data collections, and conversation with a former city employee who remembered planting the trees in both sites and lived on Morton Avenue.

Estimated Losses. We evaluated losses from all causes. Missing or obvious replacements were considered as a loss. This was consistent between sites. Survival of hawthorns on Orchard Grove (65%) was quite high relative to the other eight sites that were planted with hawthorn in the early OSTEP city plantings. The mean hawthorn survival across nine sites was 35% survival and the mode was 0% survival. Survival of honeylocusts on Morton was similar to other honeylocust plantings. If there is an error in losses it would suggest that hawthorn survival was lower than reported. This would have reduced the environmental benefits relative to a larger growing tree with higher survival rates. Thus the differences in environmental benefits reported are conservative in that errors would favor exaggerating benefits for hawthorns rather than honeylocusts.

A variety of losses that were not tree related were discovered in the 97 community sites in the OSTEP plantings. Some losses eliminated, minimized, or not considered through site selection but seen in the 97 sites in the OSTEP city plantings included airport expansion, installation of a school bus landing area, chances in design requirements, freeway or roadway construction, and resident preference for other trees or no trees. These losses are significant but in the author's judgment not part of this study and thus not discussed.

Urban Soils. Urban soils are complexes and highly variable. Where the term *urban* is first, as in Urban land-Elnora complex (UeA), more than half of the material is disturbed. Where the term *urban* is second, as in Hornell-Urban land complex (HsC), 30%–50% of the material is disturbed. Soil conditions may vary significantly in urban soils within a few feet but this is the growing media in which most urban trees survive. These two urban soil complexes were similar as stated in the paper and not growth limiting for either species in our judgment.

Nitrogen Fixation. Honeylocust is a non-nodulating legume and does not fix nitrogen. Approximately 10% of legumes fix nitrogen, including major agricultural crops such as soybeans, peas, beans, and alfalfa, thus we often extrapolate this characteristic to the family. Some trees, such as alder, do fix nitrogen, but it is not a legume and black locust is a nodulating legume and fixes nitrogen. In any event, nitrogen fixation rates are low relative to recommended rates for lawn fertilization in urban areas. Lawn quality varied in both sites, although tree growth rates were similar within a site. Trees were selected randomly in part to deal with this concern.

Pruning. No pruning except crown lifting for head space was noted. No overhead wires were present such that trees heights were limited by species characteristics not pruning saws. Since the hawthorns did not extend beyond street-side parking and above the roadway, there was no need to lift them to gain headspace for larger vehicles. Surely the hawthorns would have been limbed lower if they had been used for screening, such as in a fence row rather than for street tree use. In my experience, canopy volumes of the trees on Orchard Grove were similar to Lavalle hawthorns of similar age on the campus of The Ohio State University (Columbus, Ohio, U.S.), although these trees have died over the last ten years. Urban foresters suggest to me that smaller growing trees require a reduced pruning cycle, but pruning is fine pruning while pruning on larger trees tends to be coarser or safety pruning. Thus pruning costs may be similar over time assuming that the trees are not armed. Lavalle hawthorn is lightly armed and was considered as unarmed in this example.

Energy Conservation. Annual rates for a given year were as stated and noted by Mr. Brady. Thus we are comparing the impact of a 34.5 cm tree with a 51.5 cm tree in 2009. No attempt was made to draw conclusions regarding global events.

BVOC. Yes, plants contribute BVOC and utilize or remove BVOC. The question is net balance. The Midwest Tree Guide published by McPherson et al. (2006) is a good place to begin to understand discounting for BVOC and was referenced to assist understanding this issue for those interested. The numbers presented were estimates of annual air quality benefits of the trees studied less BVOC emitted during the same year by those same trees. The result was the net positive impact of those trees on air quality where they grew. No attempt was made to extrapolate to Brooklyn Ohio's or global BVOC emissions. This study does suggest that trees may be more likely to have a positive impact on air quality than an activity, such as adding a manufacturing business in Brooklyn might.

CO_2 Benefits. Yes, a 3.5 times larger tree would give off 3.5 times the CO_2 if disposed of in the same manner, especially when viewed in a geological time scale. In this study we compared the carbon sequestered by ten 51.5 cm honeylocusts in 2009 and compared it with carbon sequestered by ten 34.5 cm hawthorns in 2009. We found that the larger trees sequestered 3.5 times as much carbon in that period of time. What we do with the carbon once stored was not addressed. Mulch might deteriorate in a year, furniture might last another hundred years, and if the tree was landfilled, then it might store its carbon for millennia.

Storm Water. Yes, stormwater interception is based on a host of factors in addition to foliar opacity in a photograph. The hawthorn does allow water to penetrate its canopy as does the honeylocust. Roughness of bark, depth of foliage, twig surface area, and leaf surface area are among the plant related factors influencing stormwater interception. Note that most of these factors would be expected to be greater for the larger plant. Thus I suggest that the paper's conclusion that stormwater retention for larger plants is greater than for smaller trees is true.

Aesthetic Values. Aesthetic values reported were not property (asset) values although they do have an origin in what is commonly called the trunk formula method. Essentially, what is being reported as aesthetic benefits is the value of the tree in the year reported less the value of the tree in the previous year. This value is called aesthetic value and is a surrogate for a host of benefits such as reduced police calls in the community, increased sales in a commercial district, ,annual increase in property value, reduced use of pain killers in a hospital, reduced domestic violence, reduced deaths during a drought and heat wave, and increased community pride. I am sure that everyone can think of additional benefits that have been reported in the literature and are lumped in i-Tree Streets as aesthetic benefits. Aesthetic value may be a poor choice as a term for what was represented. The problem is that property values is the first thing that comes to mind in a ten-second sound bite. Perhaps someone else has a better term.

What the aesthetic values as reported in i-Tree Streets *is not*, is an attempt to do what CTLA has been working on for more than a decade. Defining a meaningful value to an asset such as a tree is complex, site specific, and confounded by the issues Mr. Brady noted.

Summary. Thanks for the opportunity to clear up misconceptions and further explain what we did. We think that when you consider that the cross-sectional area of each honeylocust is more than two-times that of a hawthorn and that i-Tree Streets is using canopy volume which is a cubic measure of size, that eight-times the benefits is expected. We also feel that we did show that in the 46th year following planting, that ten honeylocusts produced 7.5 times the annual benefits of ten hawthorns planted in similar circumstances. We further hope we showed how this might be used to market what we do in dollars to a public who profess to be interested in economic returns on their investment in time or resources.

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The following letter was submitted as feedback to: Peterson and Straka. 2011. Specialized discounted cash flow analysis formulas for valuation of benefits and costs of urban trees and forests. Arboriculture & Urban Forestry *37(5):200–206. The author response follows the letter submission.*

To whom it may concern:

Peterson and Straka (2011) use the following data on white oaks (*Quercus alba*) to "standardize" their models:

* white oaks live 120 years
* white oaks are structurally sound for the first 90 years
* white oaks provide significant canopy coverage around 10 years of age
* white oaks can be bought and planted for USD $70.00
* white oaks 60.96 cm in diameter can be removed for $406.00

Theoretically, any of these items are possible. Taken as a whole, however, the probability that the data is representative of any white oak is small. The variables are too great.

The authors state that American Forests (2011) showed that in Atlanta, Georgia, U.S., 0.4 hectares of land with tree coverage would reduce natural gas usage by $13.67 (I assume the data is cited).

The minimum size for white oaks to provide "shade" in this study is achieved at year 10. What is not stated is the number of 10-year-old and older white oaks required to produce coverage similar to the 0.4 ha in Atlanta.

Table 3 has the annual savings for a white oak aged 10 to 90 years at $13.67. The American Forests study, however, attributes $13.67 to the value of 0.4 ha of tree coverage—not a single tree.

If I'm correct, this would be a significant error.

Establishing the future value of trees and forests is, in my opinion, next to impossible. But there appears to be no dearth in those willing to try.

I wish them luck.

Regards,

Norm Brady
St. Michaels, Maryland, U.S.

Author Response

Mr. Brady is correct about the white oak data. We used actual cost and benefit data to illustrate the use of the specialized formulas. The resulting examples were meant to be independent and cumulative valuations could be impracticable. He is also correct that the energy savings in Table 3 would be for more than the single tree. However, all of the examples were designed to illustrate the application of a specific formula and costs or revenues were merely intended to be part of that illustration. The savings in Table 3 do correctly illustrate that use, even if they overstated as part of an example. Mr. Brady is also correct in closing to note these types of calculations are difficult in practice, but, hopefully, the specialized formulas make the application easier for those who use discounted cash flow analysis to value trees and urban forests.

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