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Environmental Services Provided by Tampa's Urban Forest[1]

Michael G. Andreu, Melissa H. Friedman, and Rob J. Northrop[2]

A Brief Overview of Tampa's Urban Ecological Assessment

What is the purpose of an urban ecological assessment?

The purpose of an urban ecological assessment is to provide a detailed look into the economic and ecological characteristics and values of the urban forest. The results from this type of assessment can serve as the basis for: 1) enhancing the understanding of urban forest values, 2) improving or developing urban forest policies, 3) ensuring effective planning and management of the urban landscape and 4) providing data for the inclusion of trees within environmental regulations.

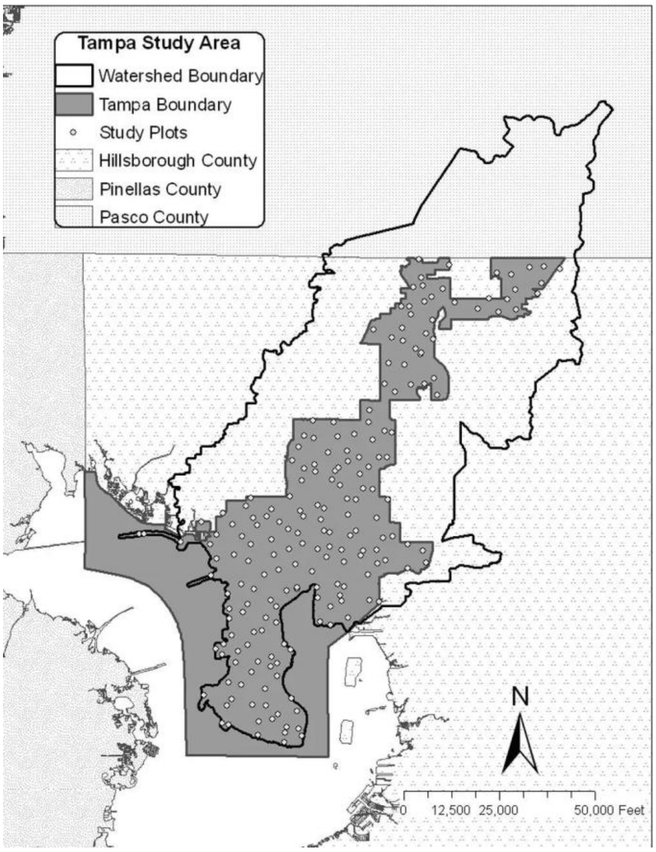

Figure 1. Distribution of study plots.

From February to July 2007, an urban ecological assessment was conducted in the city of Tampa. A total of 201 permanent sample plots were located within Tampa's city limits (Figure 1). These plots will be revisited every 5 years in an effort to monitor changes in Tampa's urban forest structure and assess how these changes are related to the functions the forest provides.

The team used the Urban Forest Effects (UFORE) model developed by the USDA Forest Service to calculate values for variables such as: tree diversity; species origin; abundance; tree density; size distribution; tree, shrub and surface covers; and leaf area by land use. The model also quantifies urban forest functions such as: energy savings, air pollution removal, carbon storage and sequestration, and compensatory or replacement values, which are discussed in this fact sheet.

Tampa's Urban Forests Conserve Energy

How can urban forests conserve energy?

Trees can reduce the energy needed to heat and cool buildings. This is done by shading buildings during the summer and blocking winds during the winter. Therefore, the proper placement of trees relative to buildings is critical for conserving energy used by buildings. Lowering building energy use has the added effect of reducing greenhouse gas emissions from power plants since they emit these gases while producing energy.

What types of trees are used to conserve energy?

Deciduous trees, such as red maple, lose all or most of their leaves in fall and winter each year. Deciduous trees are known to be excellent energy conservation trees because they generally grow a large canopy of foliage that can shade a building during the hot summer months, but then lose their leaves during the winter months, allowing the sunlight to warm the building.

Evergreen trees, such as slash pines and live oaks, do not lose all of their foliage during the winter. Therefore, they can act as a wind barrier, protecting homes from winter winds (Andreu et al 2008b).

What is the value of energy conserved by trees for residents of Tampa?

During 2007, the total amount of energy conserved in cooling residential buildings within Tampa was estimated to be 34,743 Mwh (megawatt hours), equaling a value saved of approximately $3.9 million. The amount of energy conserved by reducing the need to heat residential buildings was 2,994 MBtu (million British thermal units), saving an additional $100 thousand. Without its urban forest, it was estimated that Tampa would have emitted 6,185 tons more carbon into the atmosphere and would have burnt $125 thousand worth of fossil fuels at power plants in order to heat and cool residential buildings. In total, trees helped to conserve energy and saved the residents of Tampa approximately $4.2 million in 2007 (Table 1) (Andreu et al. 2008a).

Table 1. Energy conserved and associated dollar values due to the proximity of trees to residential buildings in 2007.

	Heating	Cooling	Total
Energy Saved			
MBtu[a]	2,994	n/a	2,994
Mwh[b]	106	34,637	34,743.00
Carbon avoided	68	6,117	6,185
US Dollars Saved			
MBtu	$100,479	n/a	$100,479
Mwh	$12,141	$3,967,322	$3,979,463
Carbon avoided	$1,389	$124,292	$125,681
Total Dollars Saved	**$114,009**	**$4,091,614**	**$4,205,623**

[a] Million British Thermal Unit

[b] Megawatt-hour

Air Pollution Removal and the Urban Forest

What are some of the most serious air pollutants affecting human health?

Some of the most common air pollutants in an urban environment are carbon monoxide (CO), nitrogen dioxide (NO2), ground-level ozone (O3), particulate matter (PM10, particles less than 10 micrometers) and sulfur dioxide (SO_2). CO is a toxic gas that enters the atmosphere through the burning of fossil fuels (e.g. automobiles and power plants). NO_2 is a respiratory irritant that can cause serious health problems. It is also a contributor to the formation of ground-level ozone (smog). Smog is created when sunlight, NO_2 and other volatile organic compounds react with one another. Smog can cause many health problems including coughing and nasal congestion, irritating those who suffer from asthma and emphysema. Smog is also known to lead to eye and nose irritation, which can damage the membranes that protect the body against diseases. PM_{10} causes health problems by penetrating the lungs when inhaled (Andreu et al. 2008a).

How can the urban forest help reduce air pollution?

One way trees remove gaseous air pollution is by direct uptake through their leaves during the process of photosynthesis. Once inside the leaf, gases may be absorbed by water to form acids or they may react with inner-leaf surfaces.

Trees also remove pollution by intercepting airborne particles. Some particles can be absorbed into the tree, but most particles are retained on the plant surface. Particles remaining on the plant surface are often re-suspended into the atmosphere, washed off by rain, or dropped to the ground when the leaf and twig fall (Escobedo 2008). Consequently, vegetation is only a temporary retention site for many atmospheric particles.

Trees play a key role in lowering temperatures in urban areas by shading buildings and pavement. The hotter it is in the city the more likely it is that smog will form. Therefore shade produced by trees can translate to a cooler, cleaner city. An individual tree or shrub's ability to remove pollutants from the air is related to its canopy size and leaf area, and to the concentration of air pollutants nearby.

How much air pollution can the urban forest remove?

In 2007, it was estimated that Tampa's urban forest removed approximately 1,360 tons of pollution, with an estimated value of $6.4 million. Two-thirds of the removed air pollution (900 tons) is attributed to the trees in Tampa's urban forest. The other one-third of air pollution removed (480 tons) is attributed to shrubs, highlighting the importance of the urban forest as a whole (Table 2).

Table 2. Tonnage and associated dollar values for pollutants removed by trees and shrubs in Tampa, 2007.

	Pollutant	English (short) tons	US Dollars
Trees	CO	70	$57,370
	NO2	50	$318,660
	O3	460	$2,796,010
	PM10	210	$855,140
	SO2	110	$165,770
Shrubs	CO	30	$27,570
	NO2	30	$167,740
	O3	240	$1,446,730
	PM10	120	$469,240
	SO2	60	$84,370
Total		**1380**	**$6,388,600**

Carbon Storage and Sequestration

How do urban forests help to store and sequester carbon?

As trees grow they remove/sequester carbon dioxide (CO_2) from the atmosphere to use during photosynthetic processes. Trees store carbon in the woody tissue and release oxygen into the atmosphere. A growing tree sequesters carbon each year and stores it, keeping carbon out of the atmosphere. The amount of carbon sequestered and stored over time is a function of a tree's size, condition, and lifespan. Young trees tend to sequester carbon at higher rates than older trees due to their greater vigor. Long-lived trees store carbon for a longer period of time than shorter-lived trees because when a tree dies most of the stored carbon is released back to the atmosphere as it decomposes. The time span for carbon storage can be extended if the wood from the tree is used to make a product (e.g. furniture).

Why is storing and sequestering carbon important?

Over time, the global carbon cycle has fluctuated and currently the concentration of CO_2 in the atmosphere is of the living trees, it is important to recognize the role of dying and dead trees. These serve an ecological role by providing ecosystem services and habitat for wildlife. In Tampa, the urban forest sequesters more carbon than it emits, and this amount can be increased over time through sound management of existing and newly planted trees.

However, overall urban forests sequester only a fraction of the total amount of greenhouse gases emitted in the city (Andreu et al. 2008a).

Can urban forests help with environmental policy initiatives?

On July 13, 2007, Florida Governor Charlie Crist signed three executive orders addressing climate change, increasing energy efficiency, and pursuing more renewable energy sources. In February 2008, Tampa Mayor Pam Iorio signed the U.S. Mayors Climate Protection Agreement to reduce greenhouse gas emissions. Urban forests can and should be made an integral component of any strategy to meet these goals. They sequester and store carbon, offsetting emissions from human activities; increase energy efficiency of homes and buildings by reducing cooling needs; and can act as a feedstock for alternative fuel production.

What is the value of stored and sequestered carbon in Tampa's urban forest?

Carbon credits are a commodity. They are bought and sold in many parts of the world today. Therefore, the amount increasing. There are many sources of CO_2, but one of the largest sources over the last century has been the burning of carbon-rich fossil fuels (oil, coal and natural gas). CO_2 is a greenhouse gas, which means that its accumulation in the atmosphere is raising average global temperatures and contributing to climate changes worldwide. These changes in temperature and climate may lead to changes in rainfall and storm patterns, and they may contribute to possible rising sea levels. These impacts may have long-term ecological, economic, social, and political effects for us and future generations.

How do we help urban forests store and sequester carbon?

In order for trees to sequester and store as much atmospheric carbon as possible, they need to be healthy. Trees in our communities need to be actively managed to maintain their optimal health. This management comes at a cost, but it pays dividends as well because it represents an investment by the community in the long-term health and vigor of the urban forest. Just as we want to encourage the management of carbon sequestered by the trees in Tampa's urban forest has a monetary value. The total carbon stored in Tampa's urban forest is estimated to be over 500,000 tons and has a value of $10.3 million if sold at ~$20 per ton. The total carbon sequestered by Tampa's urban forest is about 46,530 tons per year, which represents approximately $1 million annually. Carbon markets are dynamic in the same way that stock markets are, so the dollar value of carbon sequestered continually fluctuates.

Compensatory Value of Tampa's Urban Forest

What does the "compensatory value" of the urban forest mean?

The compensatory value of the urban forest of Tampa is an estimate of the amount of money it would cost to replace a tree with a similar species of the same size in a specific location. The compensatory value of the urban forest was calculated using guidelines from the Nowak et al. (2002) study on Brooklyn's Urban Forest. Values for trees were based on the compensatory value of trees as published by the Council of Tree and Landscape Appraisers (CTLA) (8th ed., 1992).

Compensatory value is based on four factors:

1. trunk area (cross-sectional area at 4.5 ft in height)
2. tree species
3. tree condition (health)
4. tree location

How much is the compensatory value of Tampa's urban forest?

The UFORE model calculated the compensatory value of Tampa's urban forest to be approximately $1.47 billion. This estimate includes a compensatory value for all tree species that occurred in the 2007 inventory except for palms, due to design limitations of the model.

The estimated compensatory value, however, does not discriminate for non-native invasive species. Initially, it seemed logical to remove non-native invasive trees (e.g. Brazilian pepper) from the appraised value since these are the kind of species generally targeted for removal, but because they *are* part of Tampa's urban forest, there will be a cost associated with not only removing them but also replacing them. Hence, all of the trees in Tampa's urban forest have value. Native, non-native, and invasive species in Tampa provide ecological services such as carbon sequestration and pollution removal. Therefore, if management actions choose to remove them, then consideration will need to be taken to replace them in order to compensate for the loss of services they provided.

The compensatory value does not include the value of the many other environmental services provided by trees to Tampa's urban forest, such as improving human health and economics (Coder 1996, Wolf 2003). The urban forest is an asset that is part of the city's infrastructure and is providing many services to the city at a relatively low investment and maintenance cost compared to engineered services such as water treatment systems or transportation networks.

How can the compensatory value of the forest be used?

The compensatory value is regularly used to determine monetary settlement for damage or death of plants through litigation, insurance claims, loss of property value for income tax deductions, and real estate assessments. It is based, in part, on the replacement cost of a similar tree (size, health, location) of the same or similar species and is an estimate of the amount of money the tree owner should be compensated for tree loss. In the case of Tampa, the compensatory value is an important figure to estimate dam- age to the urban forest following large storm events such as a hurricane. Frequently the Federal and State government need quantitative estimates from city officials to justify sending emergency relief. This figure can be used as a basis for estimating the current value of the urban forest, should such an event occur.

The content of this fact sheet was derived from the "City of Tampa: Urban Ecological Analysis" and the full report can be viewed by visiting http://www.sfrc.ufl.edu/urbanforestry/Files/TampaUEA2006-7_FinalReport.pdf.

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[2] Michael Andreu, associate professor, forest systems, UF/IFAS School of Forest, Fisheries, and Geomatics Sciences; Melissa Friedman, research and extension writer; UF/IFAS Department of Environmental Horticulture, Center for Land Use Efficiency, Gainesville, FL; Robert J. Northrop, program county Extension agent IV, M.S., urban forestry, UF/IFAS Extension Hillsborough County, Seffner, FL; UF/IFAS Extension, Gainesville, FL 32611.