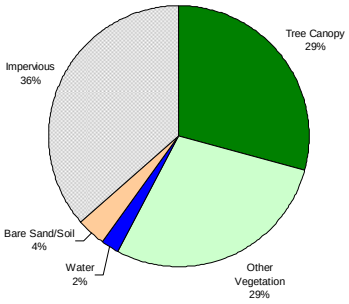
City of Tampa Urban Ecological Analysis 2006-2007 Executive Summary

In October 2006 the City of Tampa's City Council directed the Parks and Recreation Department to oversee an ecological analysis of the city's urban forest resources. This report describes the methodology used to conduct the inventory and assessment; quantifies the change in overall canopy coverage 1996 to 2006; provides a three-dimensional description of the forest structure and composition; and provides a detailed look into some of the economic and ecological values of the City of Tampa's urban forest. The outcomes from this study can serve as the basis for: enhancing the understanding of the urban forest's values, improving urban forest policies, planning and management, and providing empirical data for the inclusion of trees within environmental regulations.

The University of South Florida combined the use of high resolution imagery (1 meter) and a more robust approach to spatial analysis than used in the 1996 study as part of its investigation into urban forest cover and distribution.

- Overall citywide tree cover increased between 1996 and 2006.
- Tree cover in 2006 appears to have returned to 1970's levels.
- High-resolution 2006 land cover classification indicated the City of Tampa was comprised of 29% tree canopy, 29% other vegetation, 2% water, 4% bare sand/soil and 36% impervious surface.
- Residential, public/quasi-public institutional and right-of-way were the top three land use categories in terms of acres of tree canopy, representing over 78% of the 21,716 acres of tree canopy within the City of Tampa.



During spring – early fall of 2007 the University of Florida School of Forest Resources and Conservation and Hillsborough County Extension established two hundred and one plots which were sampled and analyzed to determine the vegetative structure, functions, and values of the urban forest in Tampa.

Definitions of terms used in this report:

1. **Urban Forest**: Urban forests encompass the trees, shrubs, plants, and wild/domesticated animals that live in the area regardless of origin (native/non-native, naturally regenerated, or planted/introduced).
2. **Forest Structure**: a description of the distribution of vegetation both horizontally and vertically. Forest structure attributes are a function of the community of species.
3. **Forest Function**: determined by forest structure and includes a wide range of environmental and ecosystem services.
4. **Forest Value**: an estimate of the ecological and economic worth of the various forest functions.

Summary of Tampa's Urban Forest and associated functional values

Feature	**Measure**
Number of Trees	7,817,408
Tree Cover	28.1%
Top 3 Species	red mangrove, Brazilian pepper, black mangrove
Proportion of Trees < 6-inches DBH	84%
Pollution Removal	1,360 tons/year ($6.3 million/year)
Carbon Storage	511,141 tons ($10,386,389)
Gross Carbon Sequestration	46,525 tons/year ($945,396/year)
Value of Energy Conservation	$4,205,623
Compensatory Value	$1,465,600,097

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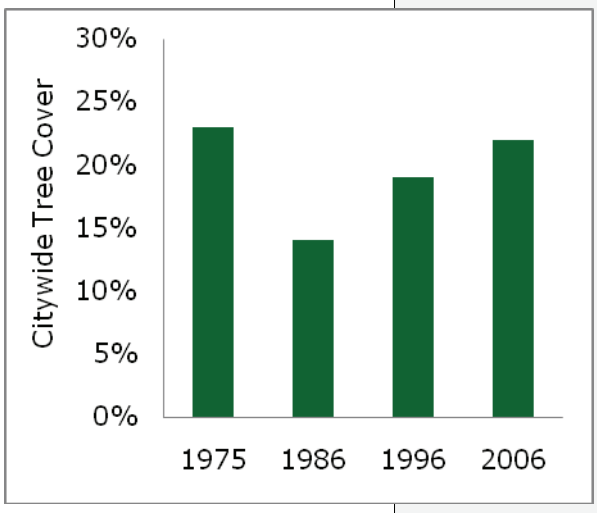
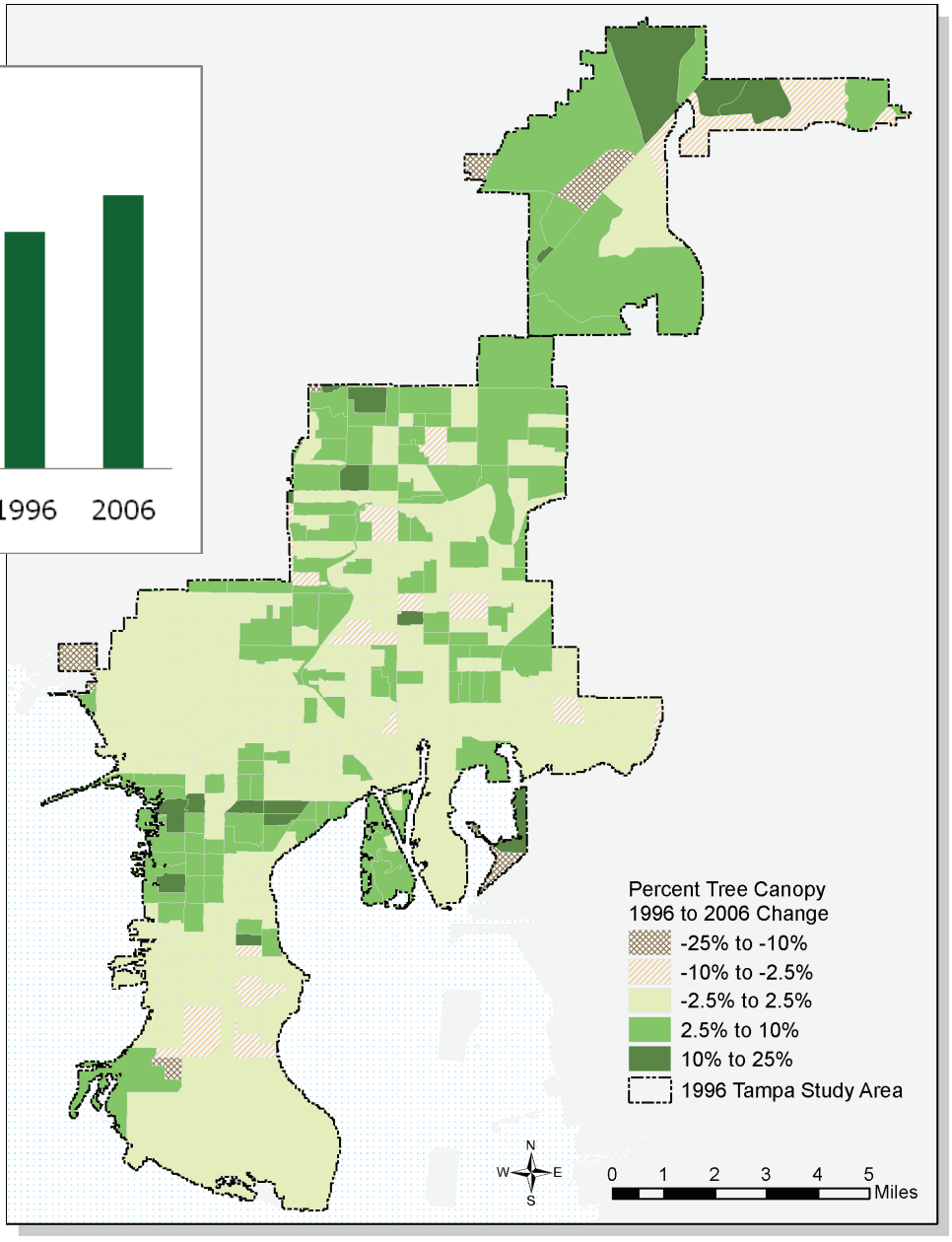
City of Tampa Historic Tree Canopy Change

Tree canopy cover in the urban forest can be expected to change over time due to the influence of human and natural factors, such as tree planting and maintenance, preservation requirements, natural disturbances and climatic factors, or other reasons. Historic tree cover was mapped from archived satellite imagery. The City of Tampa experienced an overall increase in tree cover between 1996 and 2006. In fact, after experiencing a net loss in tree canopy cover during the 1970s and 1980s, tree cover in 2006 returned to almost the same amount as in 1975. This map shows tree canopy cover change between 1996 and 2006. The graph shows citywide tree canopy cover change since 1975.





* Please note that actual tree cover was likely underestimated in each year due to limitations of historic satellite imagery. However, methods were kept consistent over time such that the magnitude of change is considered accurate.

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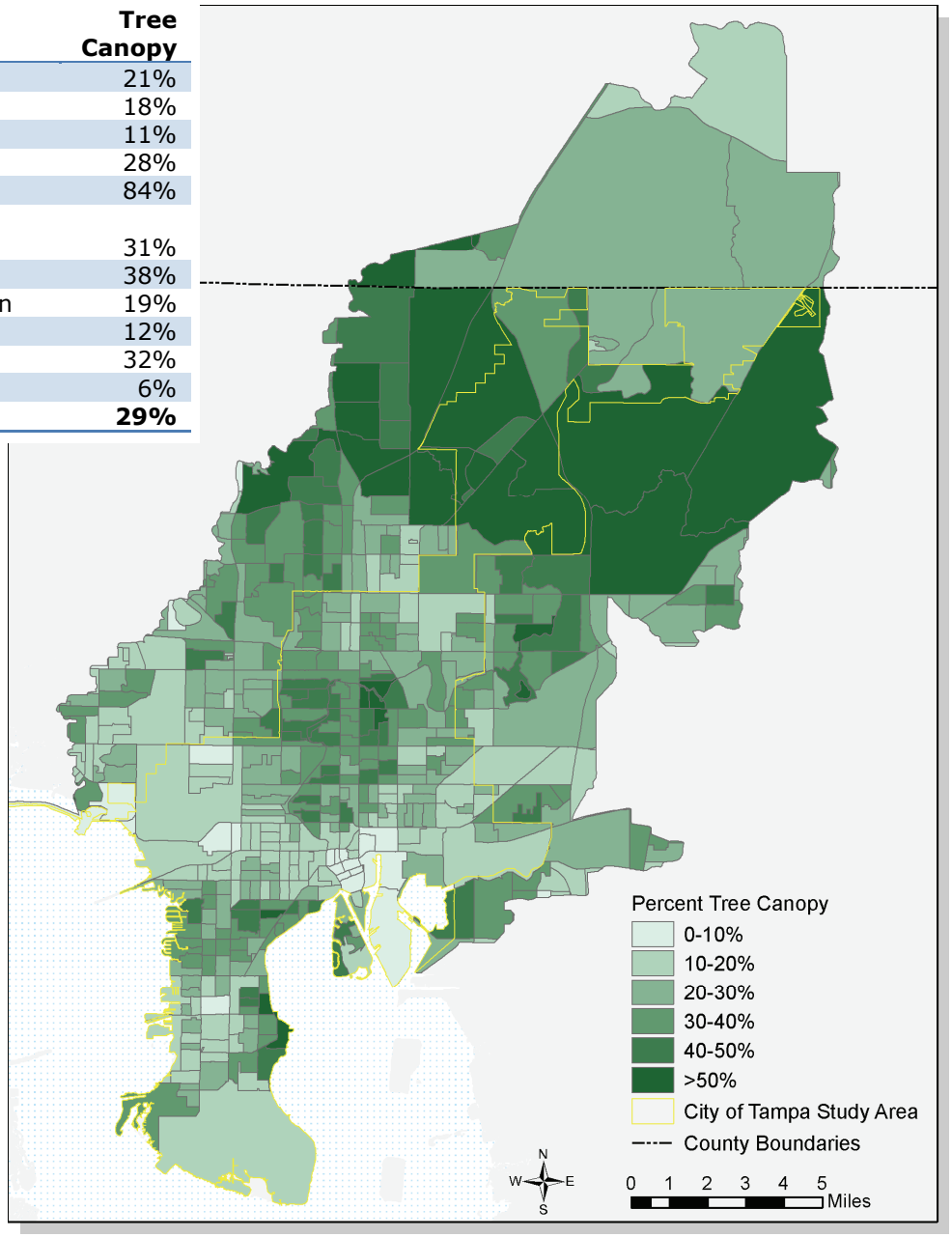
2006 City of Tampa Tree Canopy Cover

The distribution of tree canopy cover is often used as an indicator of the benefits and costs associated with the urban forest. Tree canopy cover was mapped using very high resolution satellite imagery from April, 2006. This map shows where tree canopy cover is located throughout the City of Tampa and the surrounding watershed areas. The data table provides a breakdown of the average tree canopy cover for each land use category for only those areas within the City boundaries.

Land Use Category	Percent Tree Canopy
Agricultural	21%
Commercial	18%
Industrial	11%
Public / Institutions	28%
Communications / Utilities	84%
Recreational / Open Space / Natural	31%
Residential	38%
Right of Way / Transportation	19%
Unknown	12%
Vacant	32%
Water	6%
Citywide Total	**29%**



Note: Map shows total tree canopy cover within each Census 2000 block group.

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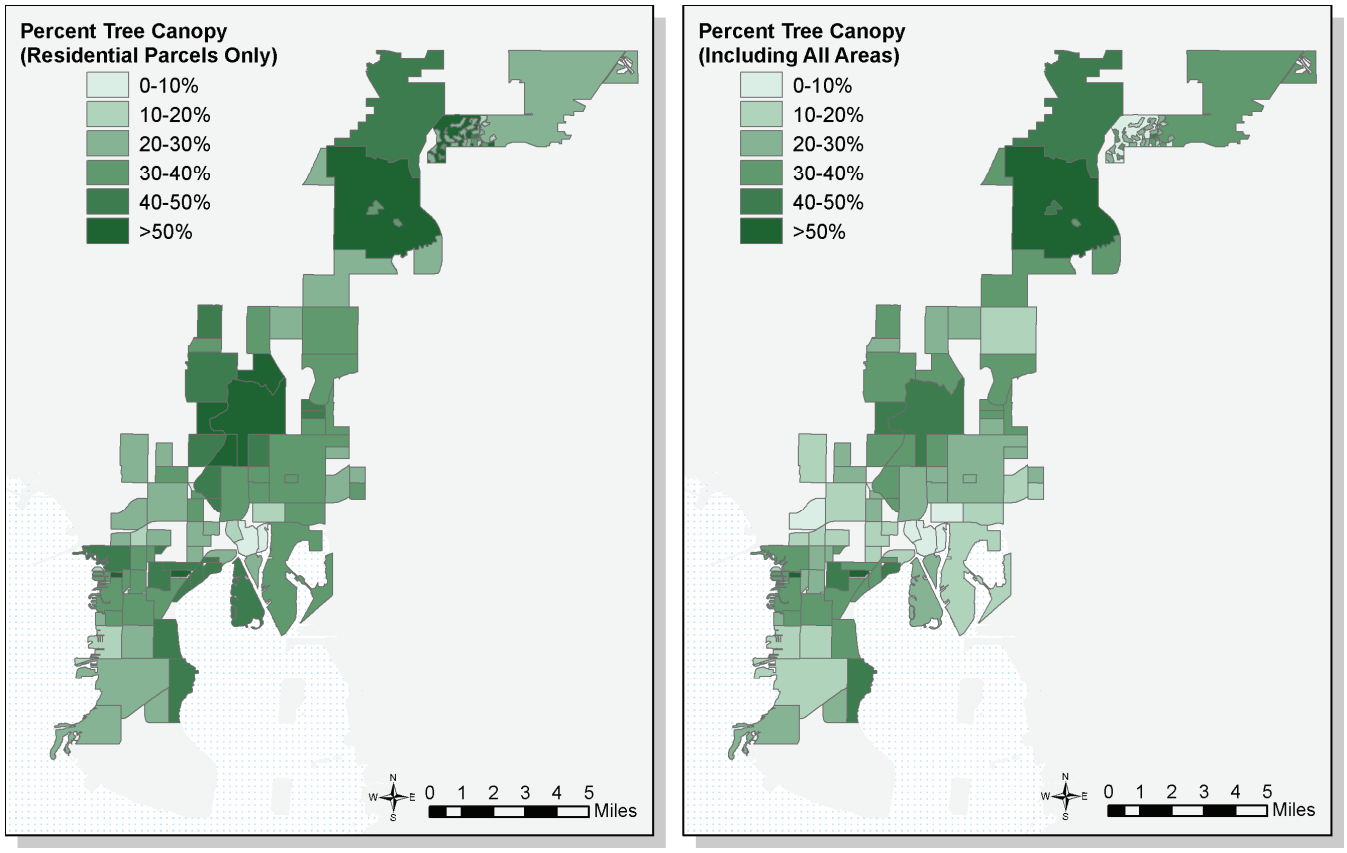
2006 Tree Canopy Cover Summarized by Neighborhood Association in Tampa

Neighborhoods provide a meaningful way to divide a larger city into localized communities where residents, businesses and government representatives can focus on locally relevant issues. The results of the 2006 High Resolution Tree Canopy Cover Assessment, part of the *City of Tampa Urban Ecological Analysis 2006-2007*, was summarized for each neighborhood association based upon the City of Tampa's August 2007 association boundaries.

Neighborhoods are composed of both public and private ownership and land uses. As one might expect, tree canopy cover has often been found to differ on residential properties when compared to commercial, right-of-way and other land uses. The maps below present the average percentage of tree canopy cover calculated for only residential properties (left) compared to all areas within each neighborhood (right).



The extent of existing tree canopy cover does not provide a complete picture of the future tree canopy possible within a neighborhood. Residents of a neighborhood association might be interested in planting additional trees in areas currently covered by lawns and other vegetation. Furthermore, both trees and other vegetation are important components of the urban forest. The table of all neighborhood associations within the City of Tampa as of August 2007 includes percent tree canopy cover, other vegetation cover (e.g. lawns) and the total of all vegetation cover.

Neighborhood Association	Tree Canopy Cover	Other Vegetation Cover	Total of all Vegetation Cover
Ballast Point	42%	20%	62%
Bayshore Beautiful	40%	21%	61%
Bayshore Gardens	34%	15%	49%
Bayside West	16%	26%	42%
Beach Park	34%	19%	54%
Beach Park Isles	18%	14%	32%
Belmar Gardens	30%	27%	57%
Belmar Shores	25%	21%	46%
Bon Air	25%	22%	46%
Bowman Heights	28%	21%	50%
Carver City / Lincoln Gardens	9%	28%	37%
Channel District	3%	6%	9%
College Hill	26%	28%	54%
Cory Lake Isles	9%	65%	74%
Courier City / Oscawana	19%	11%	30%
Culbreath Bayou	55%	15%	70%
Culbreath Heights	21%	26%	47%
Culbreath Isles	31%	17%	48%
Davis Islands Civic Association	29%	26%	55%
Davis Islands Task Force	30%	26%	55%
Drew Park	11%	23%	34%
East Tampa Business & Civic	23%	29%	52%
East Ybor Historic	13%	21%	34%
FairOaks/Manhattan Manor	14%	27%	40%
Florence Villa/ Beasley/Oak Park	15%	27%	43%
Forest Hills Community	30%	34%	63%
Forest Hills Neighborhood	33%	39%	71%
Gandy/Sun Bay South	15%	28%	43%
Golfview	43%	25%	68%
Grant Park	20%	33%	53%
Gray Gables	32%	18%	50%
Harbour Island	25%	8%	33%
Highland Pines	19%	30%	49%
Historic Hyde Park	37%	15%	52%
Historic Ybor	7%	16%	23%
Hunters Green - Brookfield	23%	17%	39%

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Neighborhood Association	Tree Canopy Cover	Other Vegetation Cover	Total of all Vegetation Cover
Hunters Green - Cypress Ridge	27%	17%	45%
Hunters Green - Deer Creek	26%	17%	43%
Hunters Green - Esprit	26%	14%	40%
Hunters Green - Fox Chase	28%	17%	45%
Hunters Green - Hampshire	31%	9%	40%
Hunters Green - Hampton On The Green	29%	15%	44%
Hunters Green - Heather Downs	36%	15%	51%
Hunters Green - Heritage Oaks	19%	33%	53%
Hunters Green - Lakeside	21%	11%	31%
Hunters Green - Laurel Ridge	35%	8%	43%
Hunters Green - Lockwood Links	23%	14%	37%
Hunters Green - Magnolia Chase	27%	17%	45%
Hunters Green - Nathans Court	24%	10%	34%
Hunters Green - Oak Crest	14%	11%	26%
Hunters Green - Oak Trace	32%	10%	43%
Hunters Green - Osprey Point	21%	17%	38%
Hunters Green - Parkside	37%	10%	47%
Hunters Green - Pinnacle	31%	12%	43%
Hunters Green - Quail Creek	27%	14%	41%
Hunters Green - Stonebridge	41%	11%	51%
Hunters Green - Waterforde	20%	12%	32%
Hunters Green - Wynstone	30%	15%	45%
Hunters Green Community	5%	21%	26%
Hyde Park North	20%	14%	34%
Hyde Park Preservation	46%	10%	56%
Interbay	25%	41%	65%
Live Oaks Square	30%	30%	60%
Lowry Park Central	39%	25%	64%
New Suburb Beautiful	55%	11%	66%
New Tampa	33%	38%	71%
North Bon Air	12%	26%	38%
North Hyde Park	15%	19%	34%
North Tampa Community	25%	27%	52%
Northeast Community	31%	25%	56%
Northeast Macfarlane	16%	28%	44%
Northview Hills	21%	36%	56%
Oakford Park	19%	25%	43%
Old Seminole Heights	40%	23%	63%
Old West Tampa	20%	21%	42%
Palma Ceia	30%	20%	50%
Palma Ceia West	23%	22%	45%
Palmetto Beach	15%	24%	39%
Parkland Estates	40%	15%	55%
Plaza Terrace	24%	23%	48%

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Neighborhood Association	Tree Canopy Cover	Other Vegetation Cover	Total of all Vegetation Cover
Port Tampa City	28%	36%	65%
Ridgewood Park	35%	19%	55%
Riverbend	43%	24%	67%
Rivergrove	38%	21%	60%
Riverside Heights	39%	25%	63%
South Seminole Heights	40%	20%	60%
Southeast Seminole Heights	36%	23%	60%
Stadium Area	21%	22%	42%
Stoney Point	27%	18%	45%
Sulphur Springs	36%	22%	58%
Sunset Park	37%	20%	57%
Swann Estates	27%	22%	49%
Tampa Downtown Partnership	5%	9%	14%
Tampa Heights	25%	25%	50%
Tampa Palms	67%	15%	82%
Tampa Palms - The Kensington	30%	15%	45%
Tampa Palms - The Sanctuary	48%	21%	69%
Temple Crest	32%	25%	56%
Terrace Park	20%	32%	52%
The Marina Club Of Tampa	6%	17%	23%
Undefined Neighborhood	19%	37%	56%
University Square	25%	28%	52%
Uptown Council	7%	9%	16%
Virginia Park	30%	23%	53%
VM Ybor	24%	20%	44%
Wellswood	32%	24%	57%
West Meadows	45%	25%	70%
West Riverfront	19%	23%	42%
Westshore Palms	19%	24%	44%
Woodland Terrace	40%	29%	69%
Ybor Heights	29%	21%	50%

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Methods Used During the Ecological Assessment

What is the purpose of the Urban Ecological Analysis?

The ecological assessment provides a detailed look into some of the economic and ecological values of the City of Tampa's urban forest. The outcomes from this study can serve as the basis for: enhancing the understanding of the urban forest's values, improving urban forest policies, planning and management and providing empirical data for the inclusion of trees within environmental regulations.

When did the assessment of Tampa's urban forest take place?

The field work for the urban forest assessment was conducted from February to July, 2007. Data analysis and reporting was completed in the Spring of 2008.

How many plots were studied?

A total of 201 permanent inventory plots were located within Tampa's political boundary. A systematic random sampling design was used to achieve a complete geographic distribution of inventory plots throughout the city and to ensure that an accurate, unbiased assessment was conducted. Precise latitude and longitude readings from GPS units for each plot location will allow researchers to relocate the plots over time to monitor changes in Tampa's urban forest structure and function

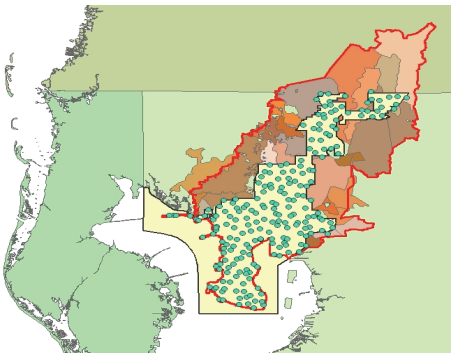


Figure 1: Distribution of study plots.

What information was gathered for the assessment?

Data collected during the assessment included land use, the percent of ground, shrub, tree and palm cover by species, tree diameter, tree crown width, total height, height to the live crown and tree health attributes. Obtaining these data for each plot assisted the team in understanding the structure of the forest, which then allowed them to determine the urban forest's contribution to pollution reduction, carbon sequestration and storage, conservation of energy use and economic value to the city and its residents.

What methods were used to analyze the collected data?

The team utilized the **U**rban **For**est **E**ffects Model (UFORE) created by the U.S. Forest Service to assist with the analysis of the data collected. The model has been designed to calculate values for variables such as tree diversity, species origin, abundance, density, size, cover and leaf area by land use categories. The model quantifies the following urban forest functions: energy savings, air pollution removal, carbon storage, carbon sequestration and compensatory or replacement values.

The Structure of Tampa's Urban Forest

What is the structure of a forest?

Forest structure refers to the distribution of vegetation (woody and herbaceous), both horizontally and vertically across a given area. The structure of the urban forest changes over time as plants grow, die or are added to a particular location. The structure of an urban forest influences the way the forest functions and the environmental services it can provide. For example, if reducing wind to slow soil erosion in an area is desirable, then an urban forest structure that has few overstory trees and shrubs with sparse grass and vegetation would not be as effective as one with a dense tree and shrub canopy with dense grass and vegetation.

What attributes are measured in a forests' structure?

Various physical attributes of the forest vegetation are measured and calculated to determine forest structure such as: tree density, diameter and height distribution, crown area/cover, tree health, leaf area and biomass. When the urban forest can be quantified and its structure identified, it is then possible to relate its structure to specific functions, such as energy conservation, carbon storage and sequestration, and pollution reduction

Why is it important to understand the diameter distribution of a Forest?

In Tampa, over 80% of the trees were smaller than 6 inches in diameter. In Tampa, over 80% of the trees were smaller than 6 inches in diameter (Figure 1). This would lead most to believe that the population of trees is mostly young, immature trees. However, 73% of the 1 to 3 inch trees are mangroves and Brazilian pepper. These two species tend to maintain a small diameter throughout their life and do not grow to large sizes.

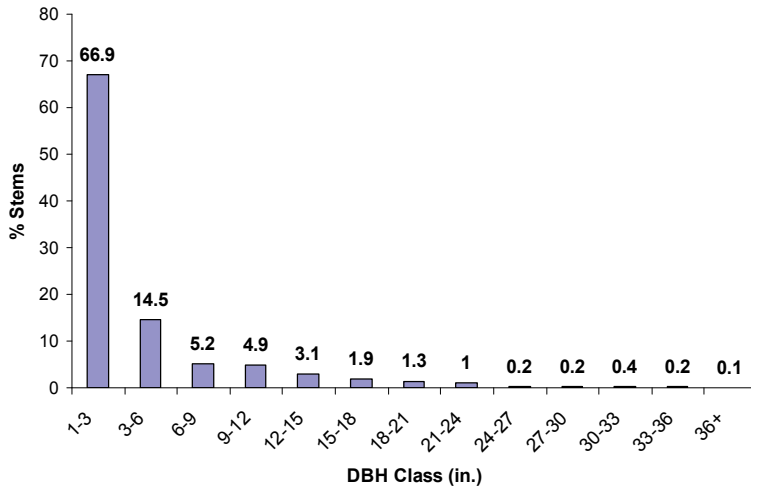


Figure 2: Diameter distribution of the trees in Tampa.

Trees greater than 36 inches in diameter represent just a tenth of one percent of the total population of trees in the city. Trees of this size consist, in large part, of native long-lived species such as oaks and bald cypress. If managers and planners want to ensure larger diameter trees exist on the landscape, they will need to be replaced over time. By understanding the diameter distribution and species information, a comprehensive strategic management plan can be developed to meet this objective. But it is important to keep in mind that both large and small diameter trees are important to ensure the diversity of structures that support the variety of values the urban forest provides.

Composition of Tampa's Urban Forest

What is the composition of Tampa's urban forest?

Tampa is located in the transitional climate zone between tropical south Florida and temperate north Florida. On our study plots we identified 93 different tree species in Tampa. This represents a unique and diverse suite of species coexisting in Tampa's urban forest.

What is the diversity of Tampa's urban forest?

Diversity or species richness is simply the number of species in a given land area. Diversity is an important attribute in the urban forest and can be an indication of its vulnerability or resiliency to such natural disturbances as insect and/or disease outbreaks. Areas that have low species diversity are more likely to be less resilient to such disturbances.

How many trees are in Tampa's urban forest?

It is estimated that there are over 7.8 million trees in Tampa. For this study, a tree is defined as a woody stem with a diameter of 1 inch or greater at 4.5 feet. The top 10 most common tree species in Tampa are red mangrove (*Rhizophora mangle*), Brazilian pepper (*Schinus terebinthifolius*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), live oak (*Quercus virginiana*), laurel oak (*Quercus laurifolia*), Darlington oak (*Quercus hemisphaerica*), cabbage palm (*Sabal palmetto*), Carolina laurel cherry (*Prunus caroliniana*) and white lead tree (*Leucaena leucocephala*) (Figure 2).

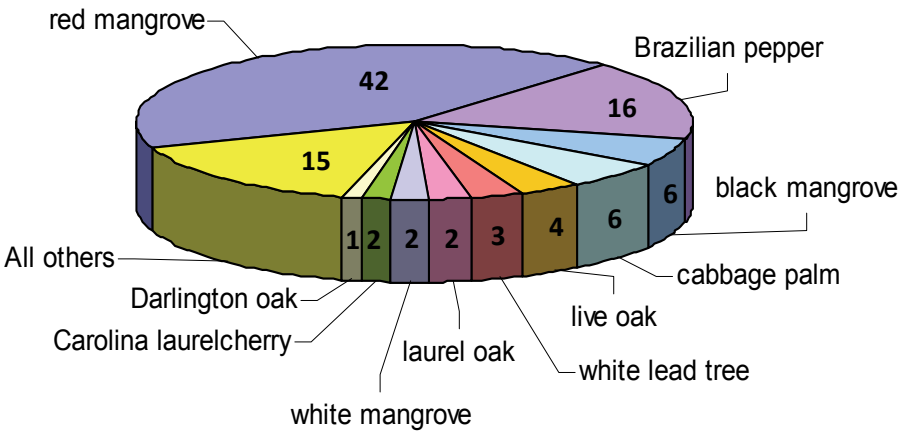


Figure 3: Relative percentage of tree species by number of stems in Tampa.

Native and Exotic Species in the Urban Forest

What is the difference between native and exotic species?

Native species are defined as those that were found in Florida prior to European colonization in the 16th century. Exotic (non-native) species are outside of their native range and have been introduced to Florida by humans, either intentionally as crops, ornamentals, etc. or by accidental transport across natural boundaries via boats, trains, and/or automobiles.

What is an invasive species?

Some of the tree species in Tampa are also classified as "invasive." Invasive species are able to spread into and dominate an area due to a lack of natural predators and/or diseases. Invasive species tend to be non-native but can also be native. Regardless, invasive species are considered as such because they negatively impact the ecological functions of the forest by reducing species diversity. Species diversity is necessary to maintain the resilience of the urban forest, especially when considering natural disturbances and the forests ability to provide efficient ecosystem services such as nutrient cycling (preventing nutrient loading), air pollution reduction, carbon sequestration, and habitat availability.

Does Tampa's urban forest have non-native and invasive species?

Of the 93 tree species found in Tampa, 76% are native to North America. Of those, approximately 50% are considered to be native to Florida (Figure 1). From an ecological perspective the fact that only half of the species are native to this state is less than desirable. But perhaps of greater concern is that one of the most common tree species in Tampa, Brazilian pepper (*Schinus terebinthifolius*), is both non-native and invasive. It readily spreads into disturbed areas such as fields and ditches, along canals and in flat wood forests, creating thickets that are costly to eradicate. The dominance of this species is not confined to Tampa as it is estimated to be established on over 1 million acres throughout the state.

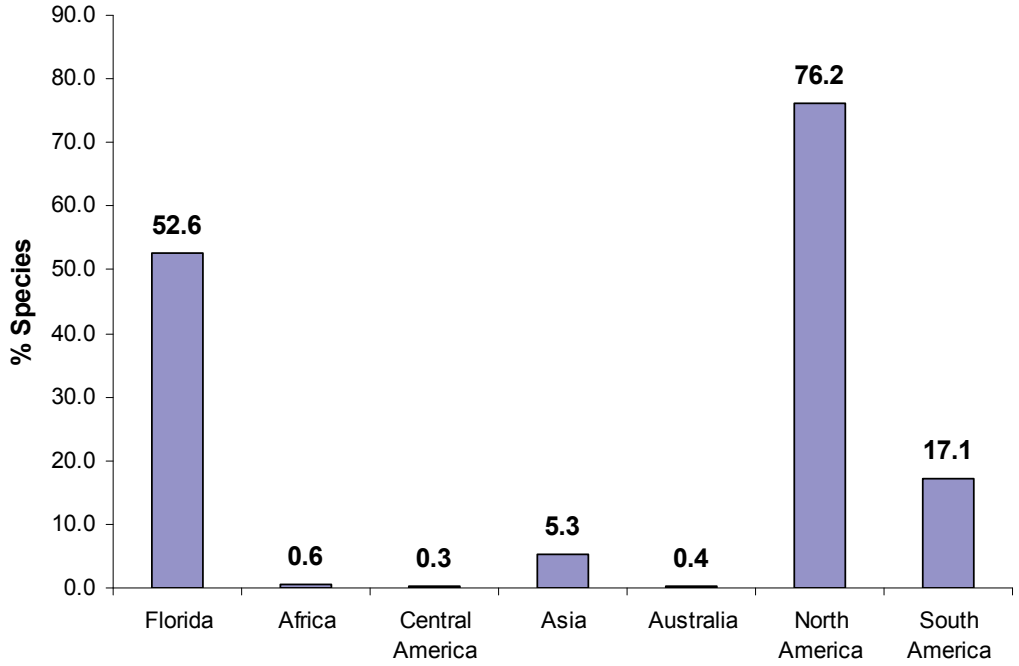


Figure 4: Percentage of tree species found in the study by their respective region of origin. Species native to Florida are a subset of the species native to North America.

Tree, Shrub and Ground Cover of the Forest

What is tree cover?
Tree canopy cover is a common metric used to quantify the amount of area directly and indirectly influenced by trees. It is ecologically important because it indicates how much of an effect the forest has on the micro-climate (e.g. shade in parking lots and homes) as well as how much rain is intercepted by the trees. Tree cover is also important because it helps provide shade, acts as a windbreak, and helps reduce air pollution.

How much tree cover is in Tampa?
The UFORE study results show that the city wide average tree cover is approximately 28%.

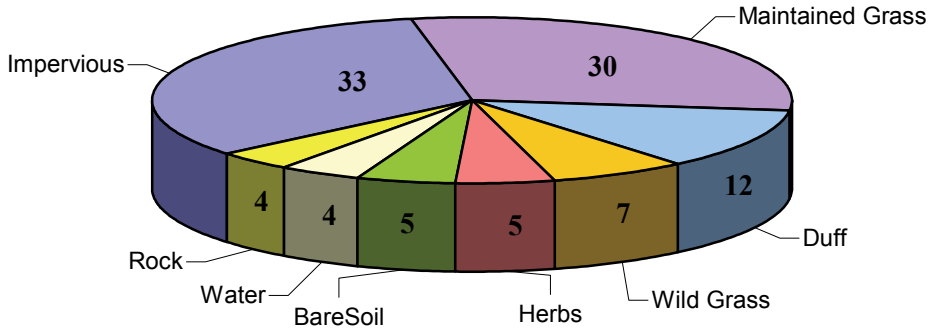
What is shrub cover?
Shrub cover is often overlooked and undervalued as a component of the urban forest. Like tree cover, it is an estimate of the amount of area in the urban forest covered by shrubs. Shrub cover is an important attribute of the urban forest because it adds structural complexity and diversity, both of which have ecological and aesthetic value. In addition to providing some of the same benefits as trees, such as preventing soil erosion and nutrient runoff, shrubs also help remove pollutants from the atmosphere.

How much shrub cover is in Tampa?
In Tampa, it is estimated that approximately 13.5% of the city is covered with shrubs.

What is ground cover?
Ground cover is divided into two broad categories: impervious (asphalt, buildings, and cement) and pervious (bare soil, duff, herbs, maintained grass, rock, un-maintained grass and water) surfaces. Urbanization tends to increase the amount of impervious surface, which affects hydrological processes that occur such as aquifer recharge and surface runoff. Pervious surfaces allow the natural cycle of rainfall and stormwater flow to soak into the ground and maintain a healthy and plentiful aquifer.

How is ground cover distributed in Tampa?
Thirty three percent of the ground cover in the city is classified as impervious. The remaining 77 percent consists of pervious surfaces, including maintained grass, rock, water, bare soil, herbs, wild grass and duff (Figure 1).

Figure 5: Distribution of ground cover types in Tampa.



The Palms of the Urban Forest

What are palms?

Palms are monocots or grass-like plants but they can grow tall and have woody stems like trees. While not truly trees, they perform many of the same functions as trees, such as providing cover, controlling air pollution and controlling carbon storage and sequestration.

How many palms are in Tampa?

In 2007, the total number of palms in Tampa was estimated to be 584,658. Palm species represent 7% of the trees of Tampa's urban forest.

What is the most common palm?

Cabbage palm is the most abundant palm in Tampa, accounting for six percent of the urban forest. It is also the state tree of Florida and is the only native palm of large stature found in the city. Cabbage palm is one of the top ten dominant species found in the urban forest and accounts for 75% of all palms in Tampa (Figure 1). Cabbage palms are tolerant of both drought and high water tables, and therefore can exist across a broad spectrum of growing conditions. Within the urban environment it is found in parks and other natural areas. Due to the cabbage palm's high level of wind resistance it makes an ideal palm for planting near buildings and in public areas.

Are there other Florida native species of palms in the urban forest?

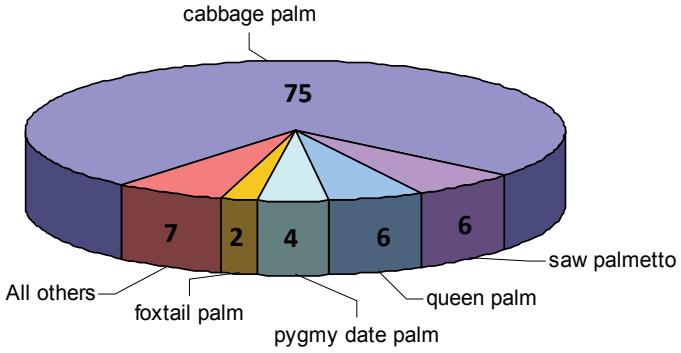
Saw palmetto (*Serenoa repens*) is the second most common of all palms in the city and is native to Florida. In less urbanized forested areas, saw palmetto is often seen as the thick palm ground cover beneath open pine woodlands. Like the cabbage palm, saw palmetto is naturally drought and insect resistant.

In addition to these native palms, many non-native palms are used to provide a distinct structural element to the city's landscape and palm species have been consistently used on residential sites and public rights-of-way to accent the city's sub-tropical climate.

Are there significant diseases affecting palms in Tampa?

Yes! One such disease is *Fusarium oxysporum*, a fatal fungal disease. This disease affects queen palm (*Syagrus romanozoffiana*), the third most common palm in the city (5.8%), and Mexican fan palm (*Washingtonia robusta*), another of the more common (1.7%), large stature palms. Researchers now suggest that the pathogen is likely being spread by wind and that palms should not be replanted onto a site where one with this disease was removed before. Another disease affecting palms in Tampa is the *Texas Phoenix palm decline*, a fatal bacterial disease. This disease affects Canary Island date palm (*Phoenix canariensis*), edible date palm (*Phoenix dactylifera*), wild date palm (*Phoenix sylvestris*) and cabbage palm, the most abundant palm in Tampa.

Figure 1: Relative number of the top five palm species based on the number of stems.



Mangroves in the Urban Forest

What are mangrove forests?
Mangrove forests are a rare ecological community within North America. Because of their sensitivity to sub-freezing temperatures the distribution of mangrove forests in the continental United States is limited to the southeast, including the coasts of North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana and Texas. These forests make up approximately 50 percent of the total number of trees in Tampa's urban forest.

Are there different types of mangrove trees?
The mangrove forest of Tampa includes three tree species that are collectively called mangroves; red (*Rhizophora mangle*), black (*Avicennia germinans*) and white (*Laguncularia racemosa*) mangrove. These three types are found in distinct but overlapping ecological zones along the coastline and coastal strands. Red mangroves are the most common (84%) followed by black (11%) and white (5%) (Figure 1).

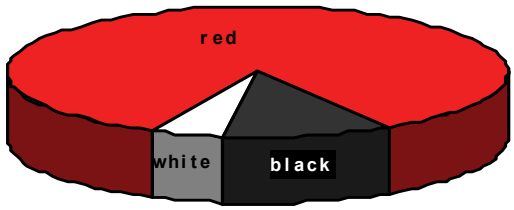


Figure 6: Relative portion of mangrove species in Tampa.

Why are mangrove forests important?
The mangrove forest is valued for its ability to filter out pollution, stabilize sediments and protect the shoreline from erosion. Mangrove forests are an integral part of the ecological functionality of the Tampa Bay estuary because they provide food, nesting and nursery areas for a great variety of fish, shellfish, birds and other wildlife. The mangrove forests also provide habitat for many of Florida's threatened and endangered species of plants and animals.

What is the value of these mangrove forests?
The mangrove forest contributes a total of $221 million to the structural value of Tampa's urban forest. This does not account for the economic value related to sport and commercial fisheries industries or the value of the ecological services mangroves provide such as nutrient cycling, erosion control, habitat, etc. Mangrove forests also help protect the inland areas from storm surges during strong tropical storms and hurricanes.

Are there regulations involving mangroves?
Mangrove trimming and alteration are regulated through the Florida 'Mangrove Trimming and Preservation Act' as amended by the 1999 Florida Legislature. The intent of the legislature is to protect and preserve mangrove resources valuable to our environment and economy from unregulated removal, defoliation and destruction. This legislation ensures that the mangrove forests are managed in a scientific manner while protecting the rights of property owners.

Urban Forests Conserve Energy

How can urban forests conserve energy?

Trees can reduce the energy needed to heat and cool buildings by lowering temperatures and shading buildings during the summer, and blocking winds during the winter. However, they can also increase energy use by shading buildings in winter but that is not a major concern in this part of Florida. Therefore, the proper placement of trees near 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 that produce the energy.

What types of trees are used to conserve energy?

Deciduous trees, such as red maple lose all or most of their leaves throughout the 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 pine, do not lose their foliage during the year. The structure of evergreen trees is better adapted to block winds and provide dense shade. Since evergreen trees do not typically lose their foliage during the winter, they also act as a wind barrier and protect homes from harsh gusts of wind.

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 the City of Tampa was estimated to be 34,743 MWh's (megawatt hours), equaling a value saved of approximately $3.9 million. The amount of energy conserved by reducing the need to heat buildings was 2,994 MBtu (million British thermal units), saving an additional hundred thousand dollars. As a result of these savings it was estimated that the total amount of carbon emissions avoided from burning fossil fuels at power plants was 6,185 tons and saved another $1.25 hundred thousand dollars. In total, trees helped to conserve energy and saved the residents of Tampa approximately $4.2 million dollars in 2007 (Table 1).

Table 1: Energy conserved and associated dollar values due to the proximity of residential buildings to 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

Compensatory (Replacement) 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. The compensatory value of the urban forest was calculated based on the guidelines 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 estimated compensatory value of Tampa's urban forest is approximately $1.47 billion dollars. A compensatory value was estimated for all tree species that occurred in the 2007 inventory, including those considered to be problematic (e.g. Brazilian pepper), and contribute to the total value of Tampa's urban forest. Initially it seemed logical to remove these trees from the appraised value, but because they are part of Tampa's urban forest, there will be a cost associated with replacing them. Therefore, all of the trees in the urban forest were included.

The compensatory value is only the replacement value and does not include the value of the many other environmental services provided by the trees in Tampa's urban forest. 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.

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 damage 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.

Air Pollution Removal and the Urban Forest

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

Some of the most serious air pollutants in an urban environment are carbon monoxide (CO), nitrogen dioxide (NO_2), ground-level ozone (O_3), particulate matter (PM_{10}) 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 an ingredient in the formation of ground-level ozone (smog). Smog can cause many health problems including, coughing and nasal congestion, irritating those with 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. Smog is created when sunlight, NO_2 and other volatile organic compounds react with one another. PM_{10}, particles less than 10 micrometers, are other air pollutants that cause health problems by penetrating the lungs when inhaled.

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 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. 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. Since the formation of smog can be correlated to increased urban temperatures, the shading affect of trees can promote a reduction in the rate of ground-level ozone formation, or smog. An individual tree or shrub's ability to remove pollutants from the air is related to its canopy size and overall vigor.

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 $6.3 million dollars. Two-thirds of the removed air pollution (894 tons) is attributed to the trees in Tampa's urban forest. The other one-third of air pollution removed (466 tons) is attributed to shrubs, highlighting the importance of the urban forest as a whole (Table 1).

	Pollutant	English (short) tons	US Dollars
Trees	CO	66	$57,367
	NO_2	52	$318,661
	O_3	456	$2,796,010
	PM10	209	$855,141
	SO_2	111	$165,773
Shrubs	CO	32	$27,570
	NO_2	27	$167,738
	O_3	236	$1,446,730
	PM_{10}	115	$469,239
	SO_2	56	$84,366
Total		**1360**	**$6,388,595**

Table 1: Tonnage and associated dollar values for pollutants removed by trees and shrubs in Tampa, 2007.

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 metabolic processes and store it as woody tissue (carbon storage). Therefore, a growing tree sequesters carbon annually and stores it for the life of the tree. The amount of carbon sequestered and stored over time is a function of a tree's stature and lifespan. Young trees tend to sequester carbon faster than older trees due to their increasing 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 (i.e. furniture).

Why is storing and sequestering carbon important?

Over time, the global carbon cycle has changed and the concentration of CO_2 in the atmosphere is currently increasing. While there are many sources of CO_2 one of the largest sources over the last century is due to the burning of carbon rich fossil fuels (oil, coal and natural gas). Since CO_2 is a greenhouse gas this accumulation is contributing to changes in average global temperatures and climate changes worldwide. These changes in temperature and climate will lead to changes in rainfall patterns, increase storm events and rising sea levels. These are impacts that 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 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 the living trees it is important to recognize the vale of dying and dead trees. They serve an ecological role by providing ecosystem services and provide 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.

Can urban forests help the 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. For these goals to be met urban forests will be an integral component of the solution. 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 that are bought and sold in many parts of the world today. Therefore, the amount 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 dollars if sold at ~$20 per ton. The total carbon sequestered by Tampa's urban forest is about 46,525 tons per year, and which could generate $1 million dollars annually if sold.