

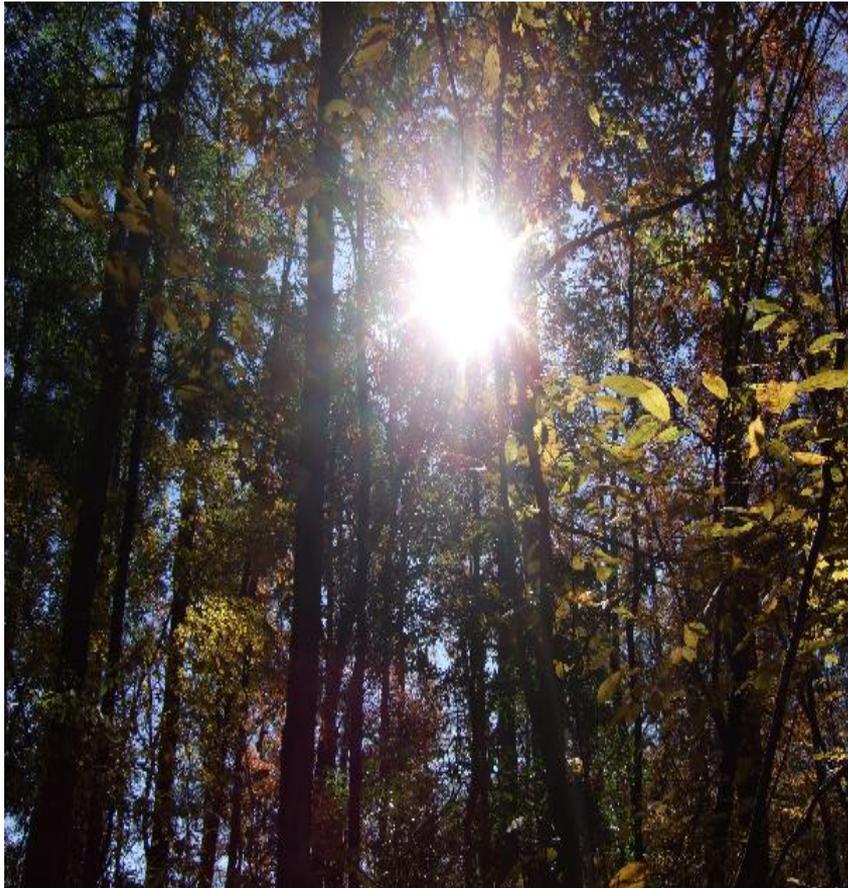
CEER 2014- Session 66  
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# Urban Ecosystem Restoration

Assessing and Managing the  
Urban Forest and Calculating  
the Benefits

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# Natural Ecology



- Native soils
- Primarily-Native flora
- Primarily-Native fauna
- Natural features and characteristics
- Natural biotics, hydrology
- Natural established Balance

# Altered Ecology



- Removal of the Vegetation
- Exposure of the soils
- Altered hydrology
- Disturbance of the naturally occurring systems
- Often, not balanced
- Disturbance leads to invasive species

# Urban Systems: Issues and Challenges



- Impervious surfaces
- Lack of planning
- Lack of understanding
- Lack of education
- Change not desired
- Budget constraints
- Urban Sprawl
- Employ the wrong “expert”

# Sprawling Facts

- Over a 20-year period, the 100 largest Urbanized Areas sprawled out over an additional 14,545 square miles. That was more than 9 million acres of natural habitats, farmland and other rural space that were covered over by the asphalt, buildings and sub-divisions of suburbia. And that was just for the half of Americans who live in those 100 cities.

([www.sprawlcity.org](http://www.sprawlcity.org))

# Impacts from Urban Sprawl

- Direct
  - Excavating of sensitive ecology, such as wetlands
  - Filling and reshaping streams
  - Destruction of Critical Habitat
  - Loss of natural areas
  - Altering of the Hydrology
- Indirect
  - Non-point Source Pollution
  - Sedimentation
  - Erosion
  - Altering of the Historical Ecology
  - Diversity shift, altering ecology



# Urban Ecosystem

- Ecosystem- a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the physical (abiotic) factors of the environment. An ecosystem is a unit of interdependent organisms which share the same habitat.

# The Urban Ecosystem



# Restoring the Urban Ecology

- Grass roots-Citizens
- Ecologists
- Environmental Scientist
- Geologist
- Urban Planners
- Arborists
- Architects  
Construction/Landscape
- Government-Federal,  
State and Local
- Archeologists
- Aligned Groups



# Building Green Cities

*TREES around your home can increase its value up to 15% or more. The trees you plant remove CO<sub>2</sub> from the air, produce oxygen and give songbirds a home. Trees provide many other benefits:*

*A WINDBREAK can lower heating bills 10-20%.*

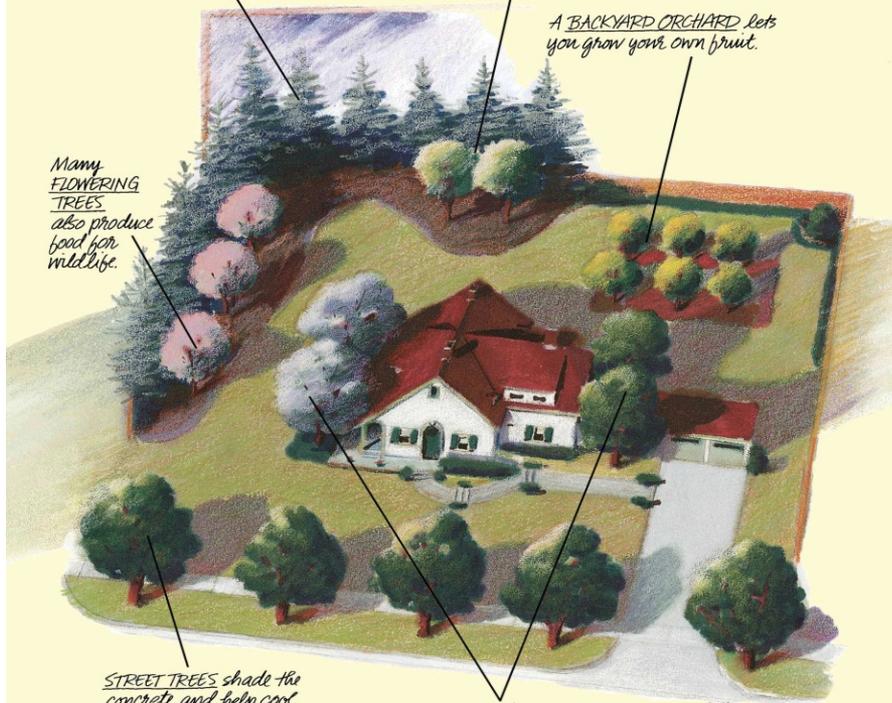
*NUT TREES can be incorporated into windbreaks or serve as shade trees.*

*A BACKYARD ORCHARD lets you grow your own fruit.*

*Many FLOWERING TREES also produce food for wildlife.*

*STREET TREES shade the concrete and help cool the entire neighborhood.*

*SHADE TREES planted east and west of your home can cut cooling costs 15-35%.*



- Desire and attitude
- Learn from the past mistakes
- Multi-disciplined applied scientific approach
- Willing politics
- Education
- Tougher standards
- Smart planning
- Smart developments
- Smart growth
- Right Tree...Right Place
- Restoration of altered system



## Assessing the Urban Forest

What are some tools to help  
Arborist/Planners manage  
trees in the landscape and  
quantify the value of trees  
empirically?

# ArborPro-Tree Assessment and Management

The screenshot displays the ArborPro 3.3 software interface. The main window shows a map of a city park area with numerous green circular markers representing tree locations. The map includes labels for various landmarks such as Catina Park, Sunken Gardens, McKay Playspot, Belgado Playground, Kish-Rooney Stadium, Oak Park Playground, Mirabeau Playspot, Gatto Pla, Hall Playground, St. Bernard Center, and Espanan Playspot. A toolbar at the top of the map area contains various navigation and tool icons. On the left side, there is a 'Trees' panel with a tree icon and a list of folders: All Properties, City Park (6524), Lists, Searches, and Reports. Below this panel is a detailed information box for a specific tree (ID: 300) with the following data:

ID: 300
Zone_Name: City Park
Area: NA
Location: NA
Common_Name: Cabbage Palm
Botanical_Name: Sabal palmetto
DBH: 13-18
Height: NA
Condition: Good
Rec_Maint: CR
X: 3670794.51235
Y: 542060.784675
Clearance Trim Cost: \$0.00
completed on 7/29/2009

At the bottom of the software window, a status bar indicates '0/6524 Records Selected - 6679 Total Sites in Inventory' and provides coordinates 'X: 3670705.64 Y: 542205.26'. The Windows taskbar at the very bottom shows the Start button, several open applications (BRC SI\_09, XP Screenshots, My Pictures), and the ArborPro 3.3 application icon, along with the system clock showing 10:06 PM.

# ArborPro Software

The screenshot displays the ArborPro 2.2 software interface. The main window shows an aerial map with green dots representing tree locations. A left-hand pane lists tree properties and lists. A 'Maintenance Search' dialog box is open, showing search criteria for work code, sub code, crew, and date range. A 'Tree Detail' dialog box is also open, displaying information for a specific tree (ID: 3129), including site details, condition, DBH, height, and species.

**ArborPro 2.2**  
File Edit View Search Reports Help

**Trees**

- All Properties
  - 1 (714)
  - 2 (471024)
  - 3 (11097)
  - 4 (113/624)
  - 5 (648)
  - 6 (399)
- Lists
  - Open
    - 2005 1/21 Complete Trim
  - Closed
- Searches
  - Recent Searches
    - {Species}=295 or {Species}=279
- Reports
  - Tree D
    - 2-4

**Maintenance Search**

Show all trees that have had the following maintenance done:

Work Code:

Sub Code:

Crew:

Limit search to the following date range:

From:  To:

Search Type:

OK Cancel

17/4506 Records Selected | Clearance Trim Maintenance Cost: \$0.00 Value: \$35,001

**Tree Detail**

Site Details | Work History

Property:  Condition:

Area:  DBH:

Location:  Exact Dia:

Height:

Site #:

Value: \$

Species:  
Common:  Botanical:

Notes:

Tree ID: 3129  
Picture | Map | [Upload Photo](#)



Representative Photo

Report OK

# Tree Management- New Orleans City Park

- Inventory- nearly 10,000, Trees Greater than 4” DBH
- GPS Located each, and mapped in GIS
- Each Tree Evaluated
- Each Tree diagnosed and given a prescription
- At Project Completion:
  - Approximately 2,500 Trees Pruned
  - Approximately 500 Palm Trees Pruned
  - Approximately 400 Trees Removed and Stumps Ground
  - Approximately 200 Trees with all vines removed

### The Benefits of Trees

- Trees combat the greenhouse effect
- Trees clean the air
- Trees provide oxygen
- Trees cool the streets and the city
- Trees conserve energy
- Trees save water
- Trees help prevent water pollution
- Trees help prevent soil erosion
- Trees shield children from ultra-violet rays
- Trees provide food
- Trees heal
- Trees reduce violence
- Trees mark the seasons
- Trees create economic opportunities
- Trees are teachers and playmates
- Trees bring diverse groups of people together
- Trees add unity
- Trees provide a canopy and habitat for wildlife
- Trees screen
- Trees provide wood/paper
- Trees increase property values
- Trees increase business traffic

\*according to [www.treepeople.org](http://www.treepeople.org)



## Project Challenge

**Can we calculate the  
ecological/environmental benefits  
of the Greenbelt area?**



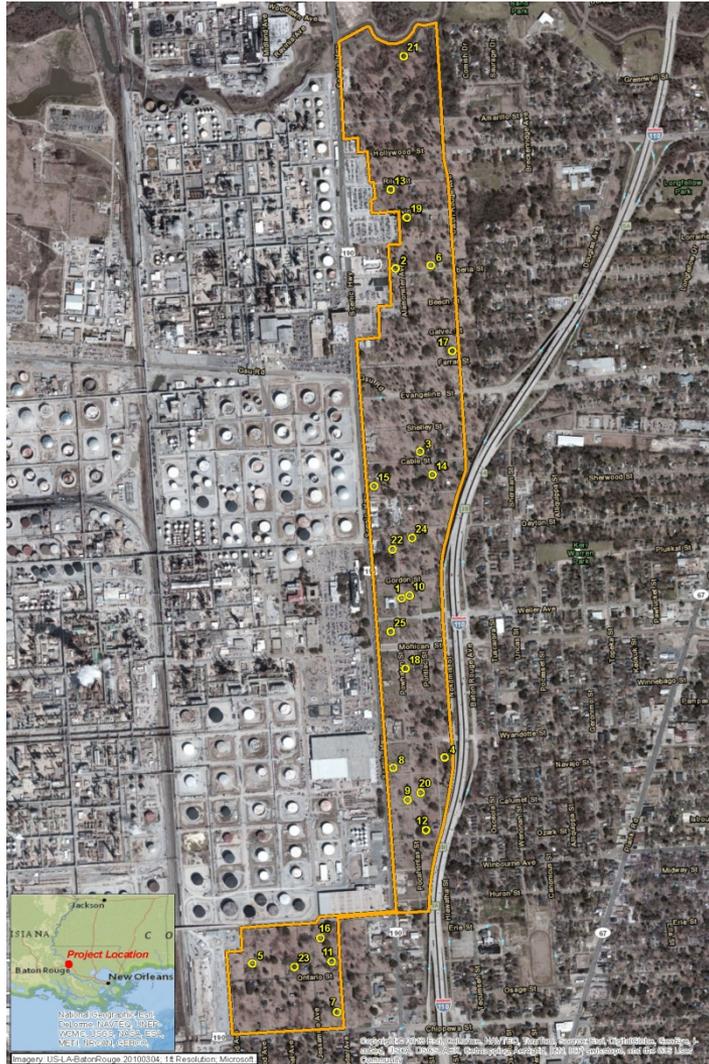
## i-Tree- USDA Forest Service

- i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools.
- i-Tree can quantify the structure of a community of trees and the environmental services that those trees provide.
- An Arborist equipped with i-Tree can run the analysis, and also interpret the findings. With i-Tree, the Arborist can more effectively plan to maximize the benefit objectives of the target site.



## Study Area Logistics

- The Greenbelt was randomly sampled with 25 1/10<sup>th</sup> acre plots
- Roughly, 200 acres, in a previously highly urbanized area, that has been converted to a “park-like” setting, for buffer and wildlife enhancement
- One field crew to collect plot data, GPS Handheld device
- Mapping services provided in the field as well as desk top assistance



## i-Tree Ecosystem Analysis

### ExxonMobil Greenbelt



Urban Forest Effects and Values  
April 2013



## Data Analysis by i-Tree

- URS Field Team collected data, performed QA/QC
- Data electronically uploaded to USDA for processing
- Draft report returned from USDA with data analysis report

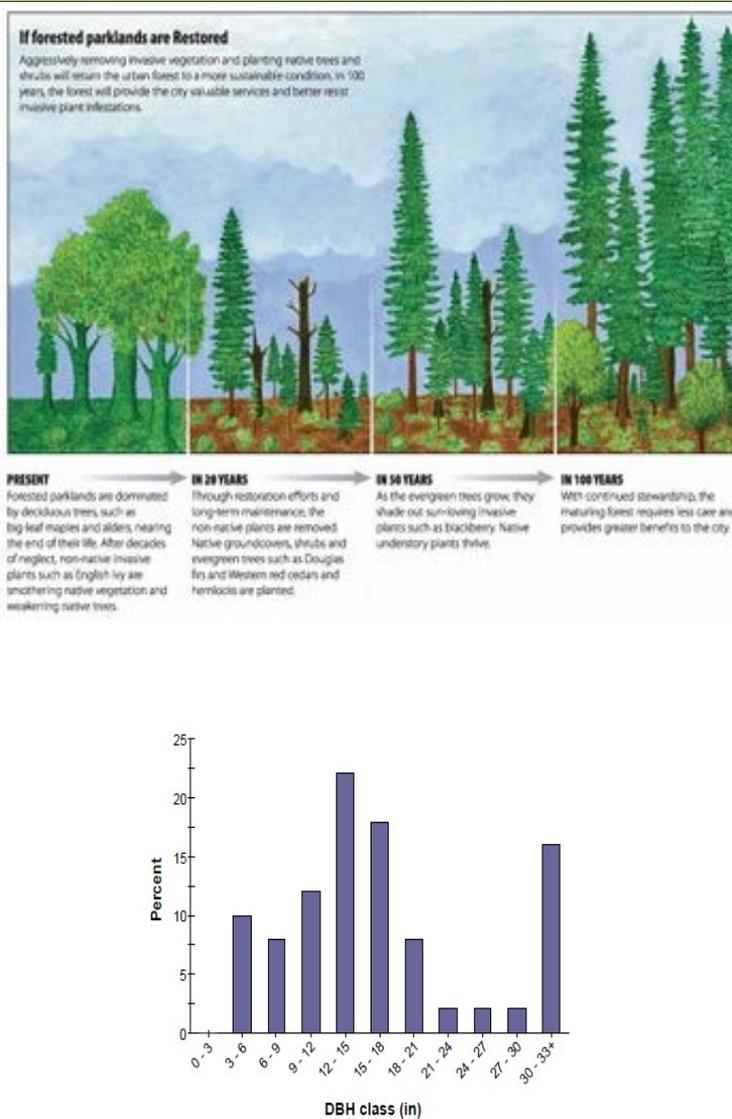


Figure 3. Percent of tree population by diameter class (DBH=stem diameter at 4.5 feet)

## Urban Forest Age Distribution at the Greenbelt

- Roughly 40% of the study area is treed
- 78% of the trees are Native
- 22% are Exotic, and should be controlled
- The Greenbelt has a diverse age distribution, regular plantings should occur to maintain the age distribution and diversity

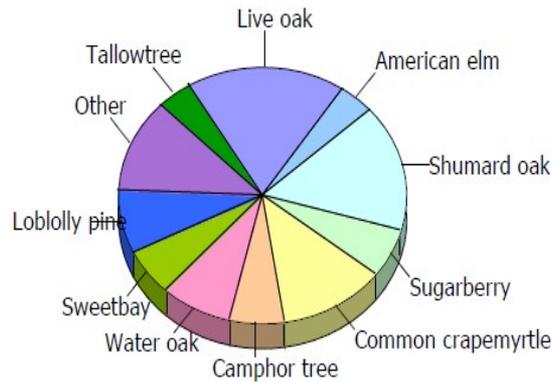


Figure 1. Tree species composition in ExxonMobil Greenbelt

<i>Species Name</i>	<i>Percent Population</i>
Live oak	18.0
Shumard oak	16.0
Water oak	8.0
American elm	4.0
Sugarberry	6.0
Common crapemyrtle	12.0
American sycamore	4.0
Sweetgum	2.0
Loblolly pine	8.0
Camphor tree	6.0

## Species Diversity at The Greenbelt

- Estimated 1,680 trees
- An estimated tree cover of 40%
- Greater than 12 species inventoried
- Site has a mixture of Native and Exotic species
- The two exotic tree species can become problematic if not controlled, Camphor Tree and Tallow Tree

## Tree / Groundcover

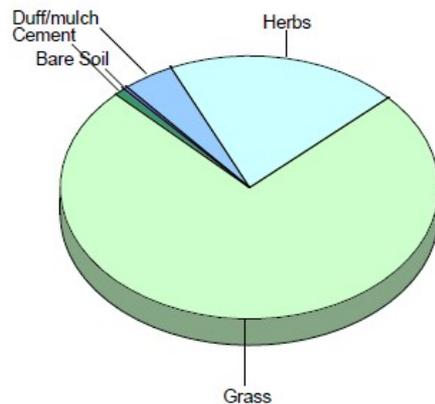


Figure 5. Percent ground cover in ExxonMobil Greenbelt

- With trees covering roughly 40% of the green space at the Greenbelt, what is the other 60%?
- Grass vegetated areas comprise the vast majority of the groundcover at the Greenbelt
- Certainly, grass cover is more beneficial than impervious surfaces, also, indicates the amount of available tree planting spaces
- The wildflower areas are not called out in this report, and it is assumed that the wildflower area is counted in the Herb and Grasses

Table 1. Most important species in ExxonMobil Greenbelt

Species Name	Percent Population	Percent Leaf Area	IV
Live oak	18.0	18.9	36.9
Shumard oak	16.0	6.7	22.6
Water oak	8.0	14.0	22.0
American elm	4.0	17.2	21.2
Sugarberry	6.0	8.6	14.6
Common crapemyrtle	12.0	2.3	14.3
American sycamore	4.0	10.0	14.0
Sweetgum	2.0	10.7	12.7
Loblolly pine	8.0	2.6	10.6
Camphor tree	6.0	1.8	7.8

## Tree Importance Value

- The environmental benefit of a tree is directly correlated to the Leaf Area of the tree, and the quantity of those trees.
- For the Greenbelt, the Live Oak (*Quercus virginiana*), scores the highest Importance Value.
- The Live Oak is a high performer, because it does not go dormant, rather it has leaves all year giving benefit to the Environment.
- Note, the top three species are Oak species.

# Trees Reduce Air Pollution

## General

- Trees and other plants make their own food from carbon dioxide (CO<sub>2</sub>) in the atmosphere, water, sunlight and a small amount of soil elements. In the process, they release oxygen (O<sub>2</sub>) for us to breathe. **Trees:**
- Help to settle out, trap and hold particle pollutants (dust, ash, pollen and smoke) that can damage human lungs.
- Absorb CO<sub>2</sub> and other dangerous gasses and, in turn, replenish the atmosphere with oxygen.
- Produce enough oxygen on each acre for 18 people every day.
- Absorb enough CO<sub>2</sub> on each acre, over a year's time, to equal the amount you produce when you drive your car 26,000 miles. Trees remove gaseous pollutants by absorbing them through the pores in the leaf surface. Particulates are trapped and filtered by leaves, stems and twigs, and washed to the ground by rainfall.

## Greenbelt Project

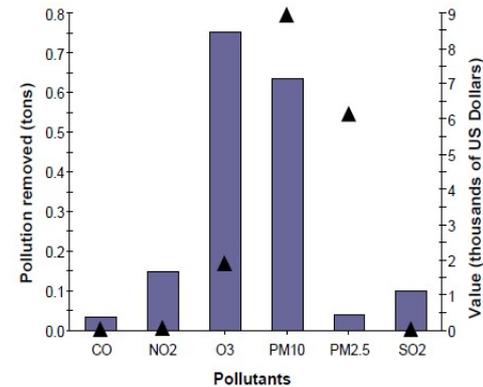


Figure 6. Pollution removal (bars) and associated value (points) for trees in ExxonMobil Greenbelt  
Pollution removal and value for PM10 excludes PM2.5 removal and value

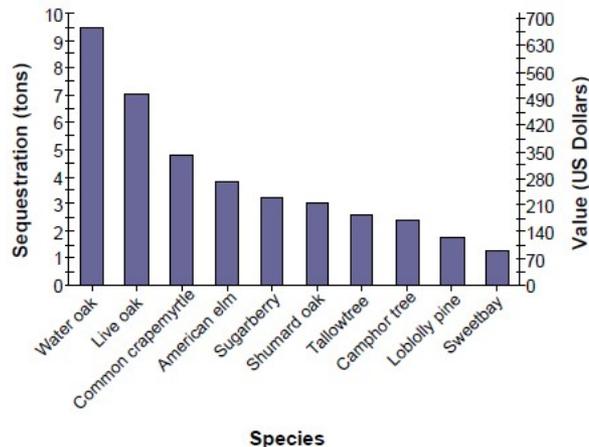
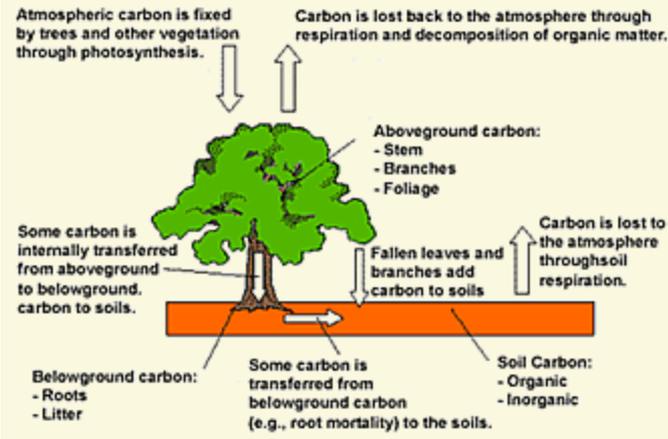


Figure 7. Carbon sequestration and value for species with greatest overall carbon sequestration in ExxonMobil Greenbelt

## Carbon Sequestration at the Greenbelt

- As the discussion of global warming heats up, so does the term “Carbon Sequestration”
- Trees help in the global warming battle by sequestering atmospheric carbon (C<sub>2</sub>O)
- The larger the tree gets the more carbon it holds
- The healthier the tree is, the longer the tree grows, the longer the carbon is held by the tree.
- Trees can also reduce the energy used by communities by shading the buildings, thus reducing emissions
- In an urban setting, right tree right place, care and maintenance is the key to success

## Estimated Oxygen Production

Table 2. The top 14 oxygen production species.

<i>Species</i>	<i>Oxygen (tons)</i>	<i>Net Carbon Sequestration (tons/yr)</i>	<i>Number of trees</i>	<i>Leaf Area (square miles)</i>
Water oak	25.28	9.48	134.00	0.03
Live oak	18.84	7.07	302.00	0.04
Common crapemyrtle	12.70	4.76	201.00	0.01
American elm	10.11	3.79	67.00	0.04
Sugarberry	8.70	3.26	101.00	0.02
Shumard oak	8.08	3.03	268.00	0.01
Tallowtree	7.00	2.62	67.00	0.00
Camphor tree	6.41	2.40	101.00	0.00
Loblolly pine	4.67	1.75	134.00	0.01
Sweetbay	3.35	1.26	101.00	0.00
Southern red oak	3.15	1.18	67.00	0.01
American sycamore	3.03	1.14	67.00	0.02
Sweetgum	2.47	0.93	34.00	0.02
Pecan	1.56	0.58	34.00	0.00

Oxygen production is one of the most commonly cited benefits of urban trees. The net annual oxygen production of a tree is directly related to the amount of carbon sequestered by the tree, which is tied to the accumulation of tree biomass.

Trees in ExxonMobil Greenbelt are estimated to produce 115 tons of oxygen per year.

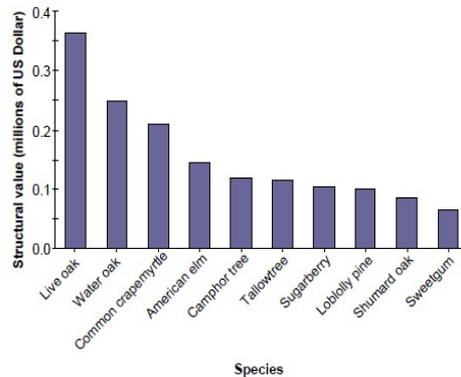
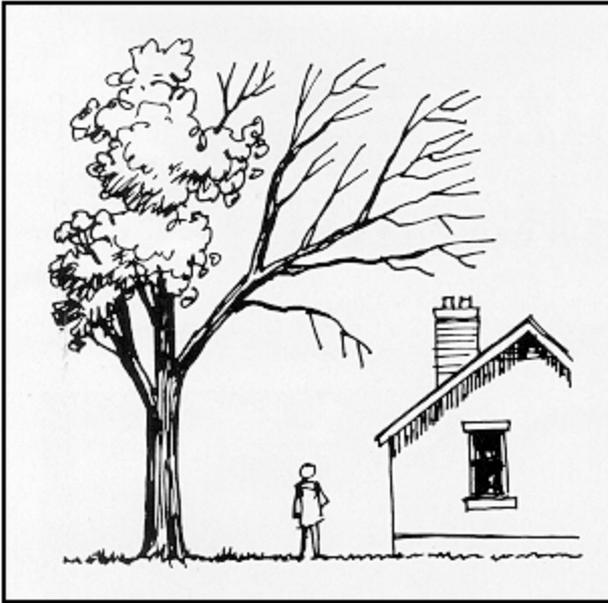


Figure 8. Structural value of the 10 most valuable tree species in ExxonMobil Greenbelt

## Structural Values

- The structural value of a tree impacts the property value
- if trees are healthy, then the value of the tree is added to the property
- In an urban setting, it is an attempt to value a tree in terms of benefit to that specific tract i.e. shade, aesthetics, enjoyment, etc.
- Live Oaks are ranked as having the highest value
- i-Tree calculated the structural value at \$ 1.67 Million for the Greenbelt

## Estimated Rainfall Interception

Rainfall Interception for Trees in ExxonMobil Greenbelt by Species				
Species Name	Tree Number	Leaf Area (mi2)	Rainfall Interception (ft3/yr)	Rainfall Interception Value (\$)
Live Oak	302	0.0417	12583.57	\$843.10
American Elm	67	0.0378	11418.43	\$765.03
Water Oak	134	0.0309	9321.17	\$624.52
Sweetgum	34	0.0236	7107.39	\$476.20
American Sycamore	67	0.022	6641.33	\$444.97
Sugarberry	101	0.0189	5709.21	\$382.52
Shumard Oak	268	0.0147	4427.55	\$296.65
Southern Red Oak	67	0.0069	2097.26	\$140.52
Loblolly Pine	134	0.0058	1747.72	\$117.10
Crape Myrtle	201	0.005	1514.69	\$101.48
Camphor Tree	101	0.0039	1165.15	\$78.07
Sweet Pecan	34	0.0031	932.12	\$62.45
Tallowtree	67	0.0031	932.12	\$62.45
Sweetbay	101	0.0031	932.12	\$62.45
<b>Total</b>	<b>1678</b>	<b>0.2205</b>	<b>66529.82</b>	<b>\$4,457.50</b>
Water interception is calculated by the price \$0.067/ft3				

# Project-Summary of Findings

- Number of trees: 1,680
- Tree cover: 40%
- Most common species: Live Oak (*Quercus virginiana*), Shumard Oak (*Quercus shumardii*), Crape Myrtle (*Lagerstroemia indica*)
- Percentage of trees less than 6" (15.2 cm) diameter: 10%
- Pollution removal: 2 tons/year (\$17.2 thousand/year)
  - Nitrogen dioxide removal is equivalent to annual nitrogen dioxide emissions from 9 automobiles
  - Nitrogen dioxide removal is equivalent to annual nitrogen dioxide emissions from 6 single-family houses
  - Carbon monoxide removal is equivalent to annual carbon monoxide emissions from 1 single-family house
  - Sulfur dioxide removal is equivalent to annual sulfur dioxide emissions from 148 automobiles
  - Sulfur dioxide removal is equivalent to annual sulfur dioxide emissions from 2 single-family houses
  - Particulate matter less than 10 micron (PM10) removal is equivalent to annual PM10 emissions from 1,790 automobiles
  - Particulate matter less than 10 micron (PM10) removal is equivalent to annual PM10 emissions from 173 single-family houses
- Carbon storage: 1,930 tons (\$137 thousand)
  - Annual carbon storage is equivalent to the annual carbon emissions from 1,160 automobiles
  - Annual carbon storage is equivalent to annual emissions from 581 single-family houses
  - Annual carbon storage is equivalent to amount of carbon emitted in the ExxonMobil Greenbelt in 116,028 days
- Carbon sequestration: 45 tons/year (\$3.21 thousand/year)
  - Annual carbon sequestration is equivalent to amount of carbon emitted in ExxonMobil Greenbelt in 2,700 days
- Oxygen production: 115 tons/year
- Rainfall interception: 66529 (ft<sup>3</sup>/yr), \$ 4,457/year
- Structural values: \$1.67 million
- Total Calculated Ecological/Environmental Benefit: over \$2 Million annually



## Urban Forest Assessment, Evaluation and Benefit Calculation

- Assessment of Greenspace components (Trees, Shrubs, etc.)
- Capture assessment into a tool for management of the system
- iTree to perform Benefits Assessment

# Conclusion and Questions



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