

GIS Data Model for Urban Tree Inventory, Management, and Research

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Presentation Outline

- i-Tree Eco & UF Management DBs
- Data Model Objectives
- Comprehensive Tree Inventory Updates
- Model Overview
- Data Workflow
- Ecosystem Services Workflow
- Reporting
- Management & Research Support
- Educational Outreach

i-Tree Eco & UF Management

Model for urban tree ecosystem services

- Carbon stored and annual sequestration
- Air pollution removal
- Avoided stormwater runoff
- Public health incidence reduction
- VOC emissions
- Pollen allergy index
- Pest risk analysis





Data Model Objectives

Framework:

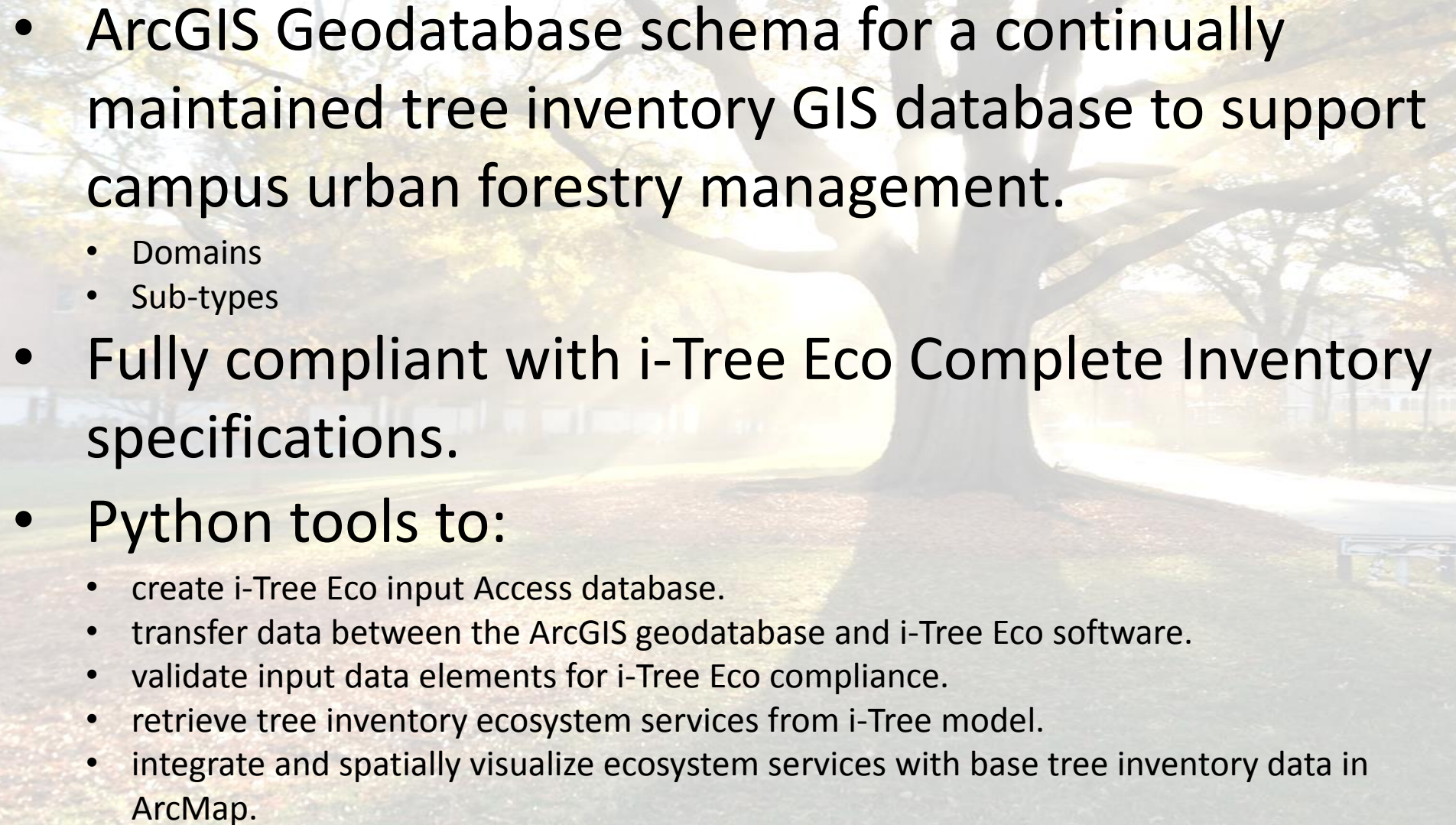
- i-Tree Eco modelling is desirable to meet management objectives
- Database management of the tree inventory often is NOT based on i-Tree Eco's MS Access database

Objectives:

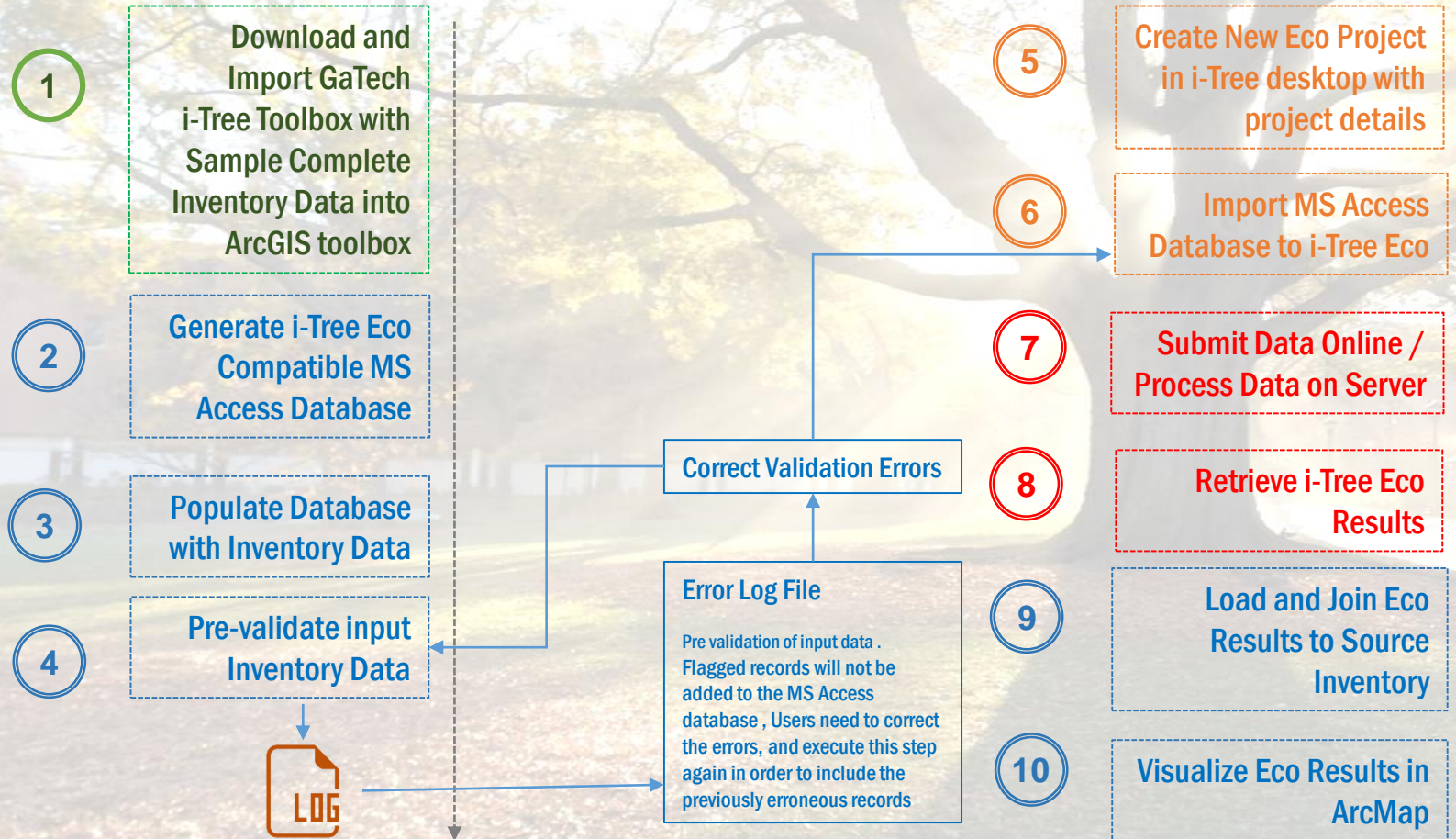
- Develop a GIS data model that supports i-Tree Eco attributes within the current/desired DBMS
- Develop tools to interface with i-Tree Eco and return ecosystem services to the DBMS for management, education, and research



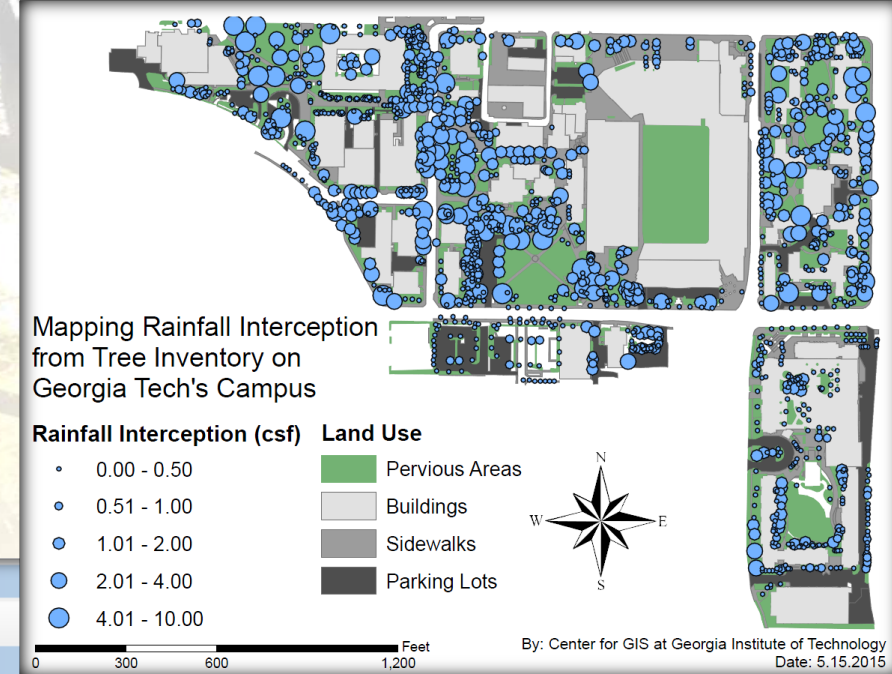
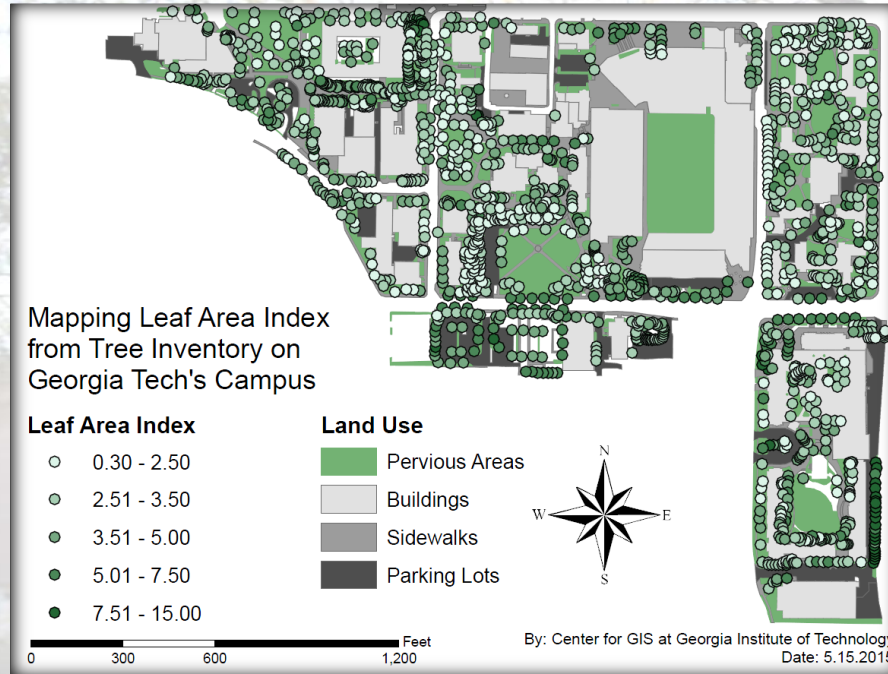
Model Overview

- ArcGIS Geodatabase schema for a continually maintained tree inventory GIS database to support campus urban forestry management.
 - Domains
 - Sub-types
 - Fully compliant with i-Tree Eco Complete Inventory specifications.
 - Python tools to:
 - create i-Tree Eco input Access database.
 - transfer data between the ArcGIS geodatabase and i-Tree Eco software.
 - validate input data elements for i-Tree Eco compliance.
 - retrieve tree inventory ecosystem services from i-Tree model.
 - integrate and spatially visualize ecosystem services with base tree inventory data in ArcMap.
- 

Model Work Flow



Ecosystem Services Visualization in ArcMap



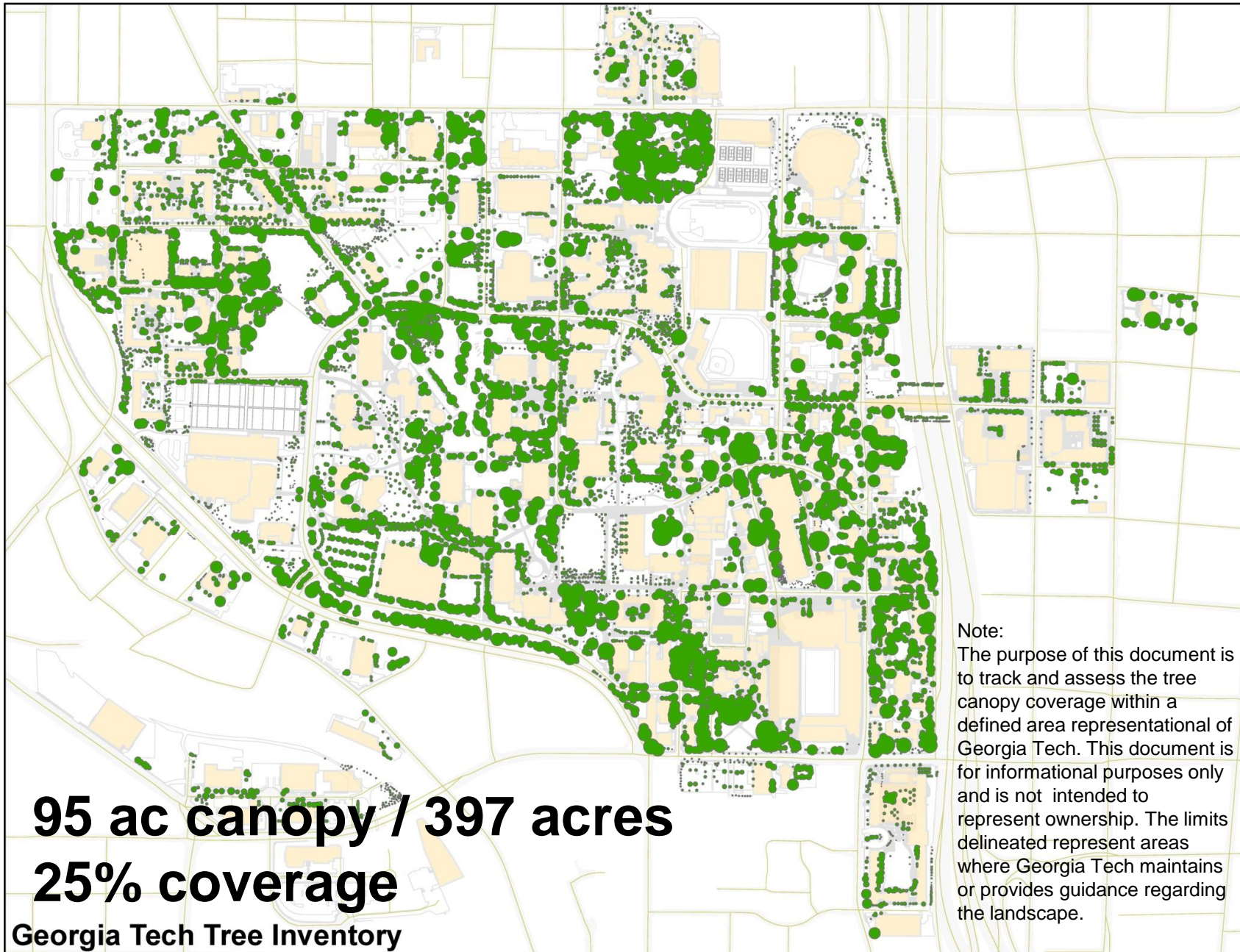
treecondition	leafarea	leafbiomass	leafareaindex	carbonstorage	gross
cellent	27.53	1.87	5.22	12.26	
cellent	51.72	3.52	5.36	11.56	
cellent	62.42	4.44	2.96	23.13	
cellent	37.9	4.68	2.16	15.01	
cellent	7.1	0.41	1.99	0.52	
cellent	5.7	0.33	1.85	0.52	
cellent	16.32	1.22	1.85	3.72	
cellent	302.54	20.37	2.73	296.73	
cellent	61.46	3.58	2.91	38.53	
cellent	61.76	3.6	3.11	39.7	
cellent	14.25	1.9	2.7	3.02	
cellent	832.79	57.91	1.93	3042.13	
cellent	476.44	45.92	4.08	202.65	
cellent	8.09	0.47	2.26	2.7	
cellent	42.29	2.46	3.71	32.57	
cellent	7.97	0.46	3.03	3.03	
cellent	8.46	0.49	3.22	2.39	
cellent	10.16	0.76	3.3	3.31	

Comprehensive Approach to Sustainability

“Georgia Tech as a Living Learning Laboratory”

- **Education:**
Learning in the Classroom
- **Research:**
Discovery in the Laboratory
- **Campus:**
Practice in Managing our Campus



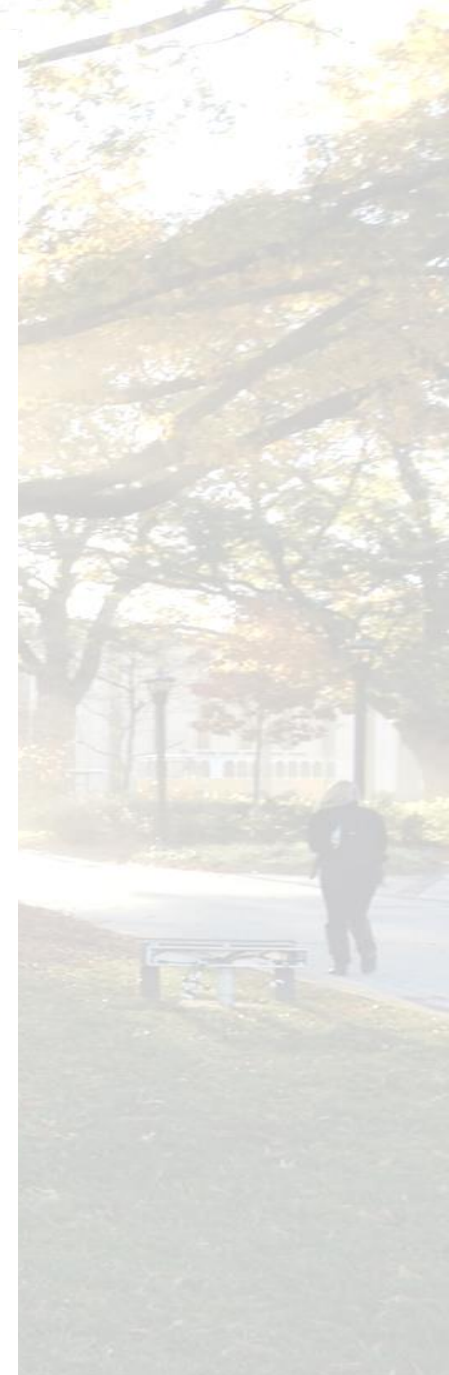


95 ac canopy / 397 acres

25% coverage

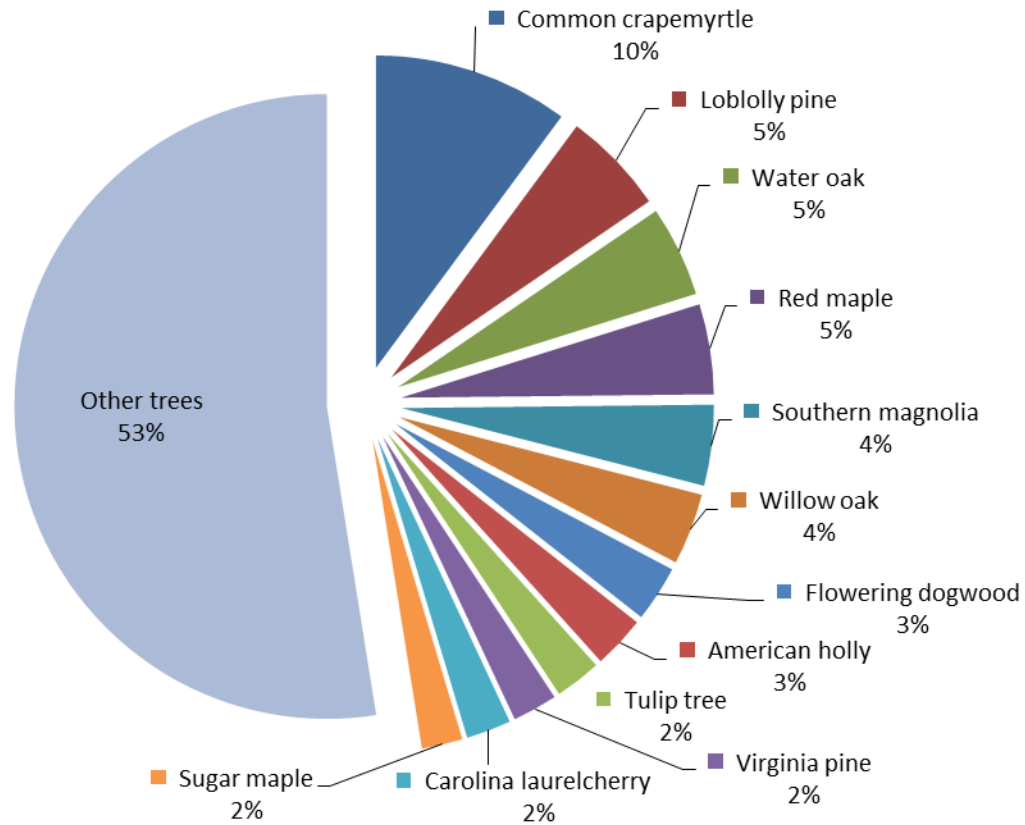
Georgia Tech Tree Inventory

Note:
The purpose of this document is to track and assess the tree canopy coverage within a defined area representational of Georgia Tech. This document is for informational purposes only and is not intended to represent ownership. The limits delineated represent areas where Georgia Tech maintains or provides guidance regarding the landscape.





Species Distribution - Top Dozen Tree Species



2012 Total trees species distribution: 11,046 Trees
11,689 Trees as of November 2015

The Performance of Trees on Campus

Campus Tree Calculations (2014)

2014 Tree Count	11,307
Canopy Cover	5,230,494 sf
% Canopy Coverage	95ac/397ac=25%
Leaf Area	16,678,954 sf
Leaf Biomass	295,596 lb
Carbon Storage	5,288,568 lb
Gross Carbon Sequestration	211,318 lb/yr
Tree Value	\$12,107,376

i-Tree Eco Model Analysis Results



**95 acres Canopy / 397 acres =
25% Campus Coverage**



Continuous Tree Inventory Updates - Campus Committees

Landscape Committee

Executive Leadership group with a focus on the campus landscape

Landscape Workgroup

Representatives from majority of campus units to discuss campus site projects and provide a platform for communication and awareness

Tree Campus USA Committee

Representatives from majority of campus units, students and adjacent communities with a focus on **TREES**.

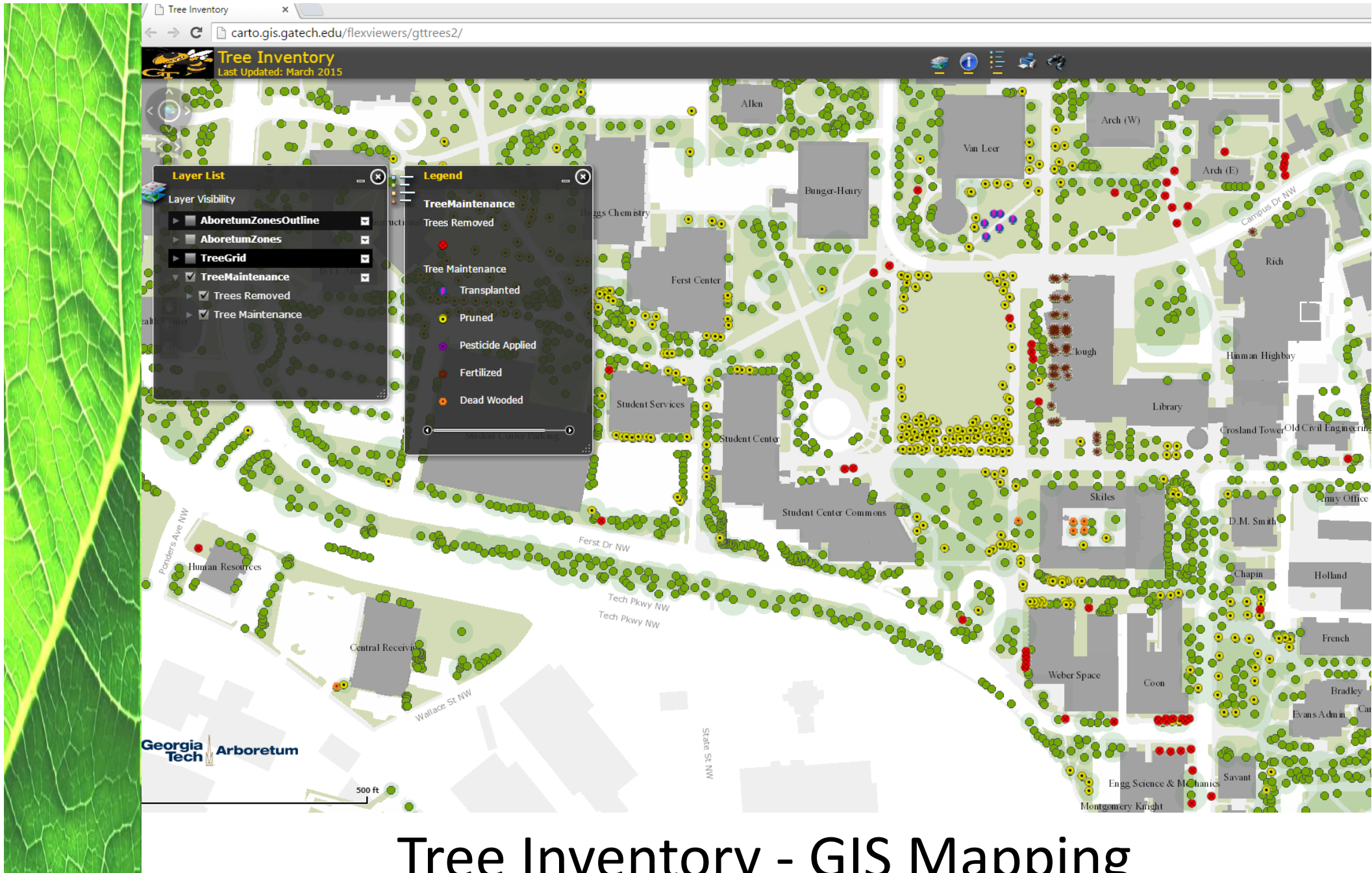




Purpose – Define the *Performance of Trees*

- Provide a platform for the development of educational tools defining the *Performance* of individual trees and the collective forest in the urban landscape
- Study at a variety of scales from the microscopic impacts of trees on soils to the regional impact of the urban forest
- Living Learning Laboratory

Georgia Tech – Campus Arboretum

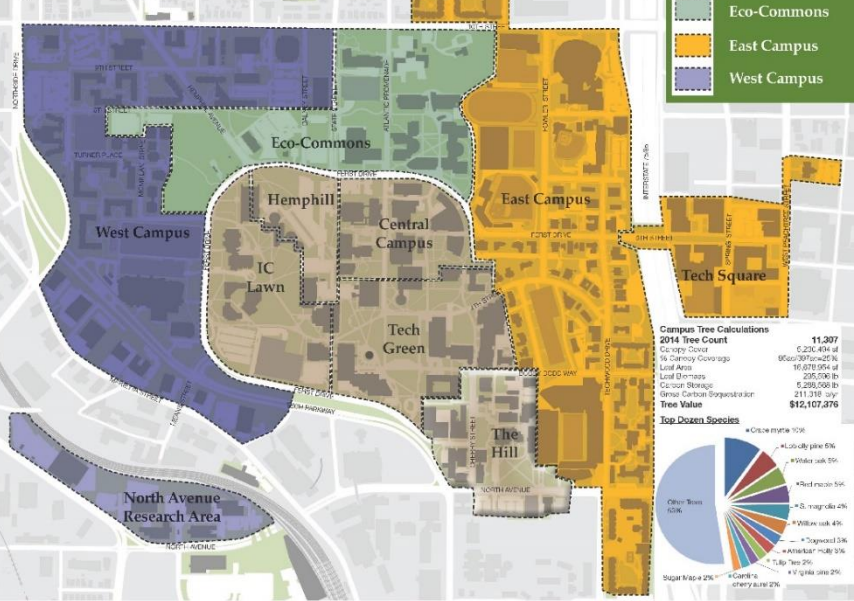


Tree Inventory - GIS Mapping



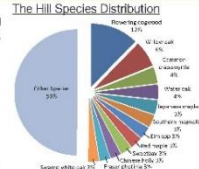
Georgia Tech Arboretum

A guide to GT's campus arboretum



The Hill Tour

The Georgia Tech Arboretum provides a platform for the development of educational tools for the development of individual trees and the collective forest in the urban landscape. By defining the performance of the individual trees and the collective forest, the students, faculty, staff, visitors and the larger urban community can begin to understand the value of one tree and the forest as a whole. The impact of trees and their performance on the environment can be studied on a variety of scales. From the microscopic impacts of trees on soils, to the regional impact of the urban forest on the air we breathe, the Arboretum provides the GT community a tool for explaining trees performance values while they are being researched as part of our Living Learning Laboratory.



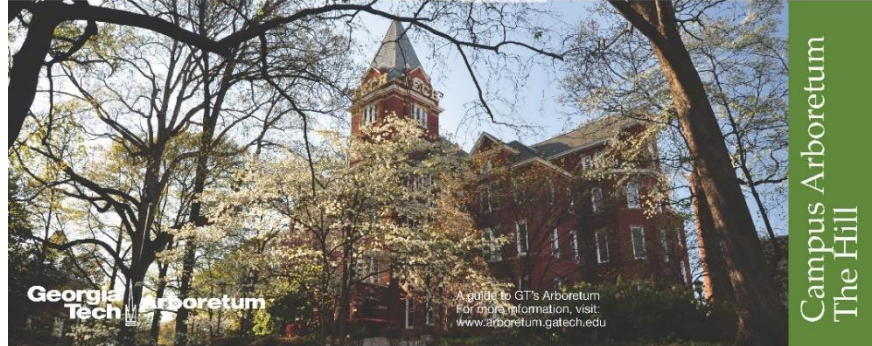
The Hill Tree Calculations

Tree Count	662
Canopy Cover (sqft)	2,232,434
Canopy Coverage	xxac/xxac=25% canopy
Leaf Area (sqft)	1,301,196
Rainfall Interception (Cubic Ft/yr)	16,814
Leaf Biomass (lb)	23,063
Carbon Storage (lb)	426,690
Gross Carbon Sequestration (lb/year)	15,322
Structural Tree Value (\$)	852,615

Tree #1 on the tour, White Oak (*Quercus alba*), is one of the oldest, and largest trees in this area. It can be seen in images circa 1888. This tree alone has the carbon storage capacity of 11,177 lbs and sequesters 217 lb/year. These calculations have been generated using the i-Tree Software suite developed by USDA Forest Service.

For more information on the performance of Georgia Tech's trees load the JUNAIO app and visit www.arboretum.gatech.edu.

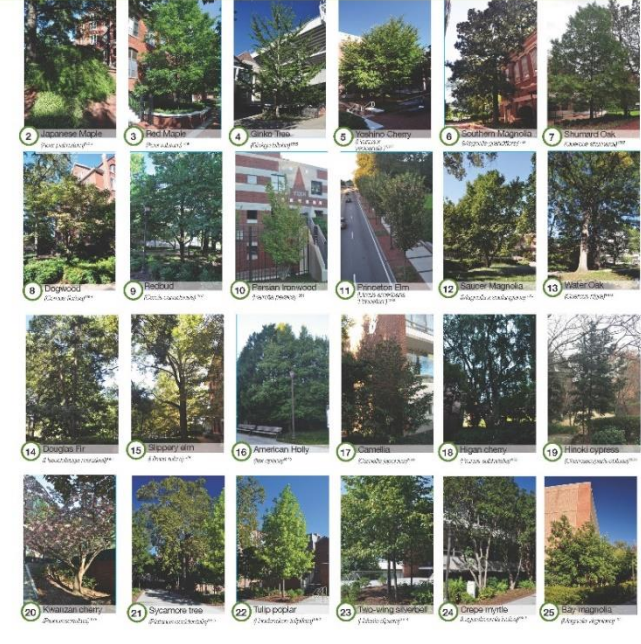
1 White Oak (*Quercus alba*)



The Hill Tour



Species List



Augmented Reality Tour Instructions



1. Load "JUNAIO" App on your mobile device.
2. Scan QR code above with the JUNAIO App.
3. Touch "Radar" and adjust the distance you are able to see items on the screen.
4. View photographed trees on the tour while walking campus.
5. Select trees for tree performance information.

For example:
 1. White Oak (*Quercus alba*)^{#01}
 Tree condition: Fair
 Total height: 88ft
 Diameter: 42.9 in
 Leaf Biomass: 190.06 lb
 Carbon Storage 11,177 lbs
 Gross Carbon Seq: 217.02 lb/yr
 Structural Tree Value: \$14,904
 Avoided runoff 151 #3/yr

Additional species found on The Hill

25. Sugar maple (*Acer saccharum*)
26. Trident Maple (*Acer buergerianum*)
27. Shumard oak (*Quercus shumardii*)
28. Black tupelo (*Nyssa sylvatica*)
29. Bald cypress (*Taxodium distichum*)
30. Smooth service berry (*Amelanchier laevis*)
31. Chinese juniper (*Juniperus chinensis*)
32. Leyland cypress (*Cupressocyparis leylandii*)
33. Winged elm (*Ulmus alatus*)
34. Southern red oak (*Quercus falcata*)
35. Pin oak (*Quercus palustris*)
36. Japanese holly (*Ilex crenata*)
37. Northern red oak (*Quercus rubra*)
38. Yaupon holly (*Ilex vomitoria*)
39. Chinese pistache (*Pistacia chinensis*)
40. American beech (*Fagus grandifolia*)
41. Scarlet oak (*Quercus coccinea*)
42. Northern White Cedar (*Thuja occidentalis*)
43. Chinese Holly (*Ilex cornuta*)
44. Chinese Elm (*Ulmus parvifolius*)
45. Japanese red cedar (*Cryptomeria japonica*)
46. Gallery pear (*Pyrus calleryana*)

Arboretum Collection

Level II - 100 species

- **Labeled** in some way as to their identity,
- **Documented** as to their acquisition (source or origin, date, etc.).

GT has more than 100 species to achieve Level II

Silver Maple **Acer saccharinum**

Native to eastern North America including Georgia, this tree becomes a primary food source for wildlife in the spring. Due to its fast growth, this tree is being researched as a potential source of biofuels. The light wood is used to make furniture, cabinets, flooring, musical instruments, and tool handles.

Georgia Tech  **Arboretum**
arboretum.gatech.edu

Hypericum calycinum

Creeping
St. John's Wort

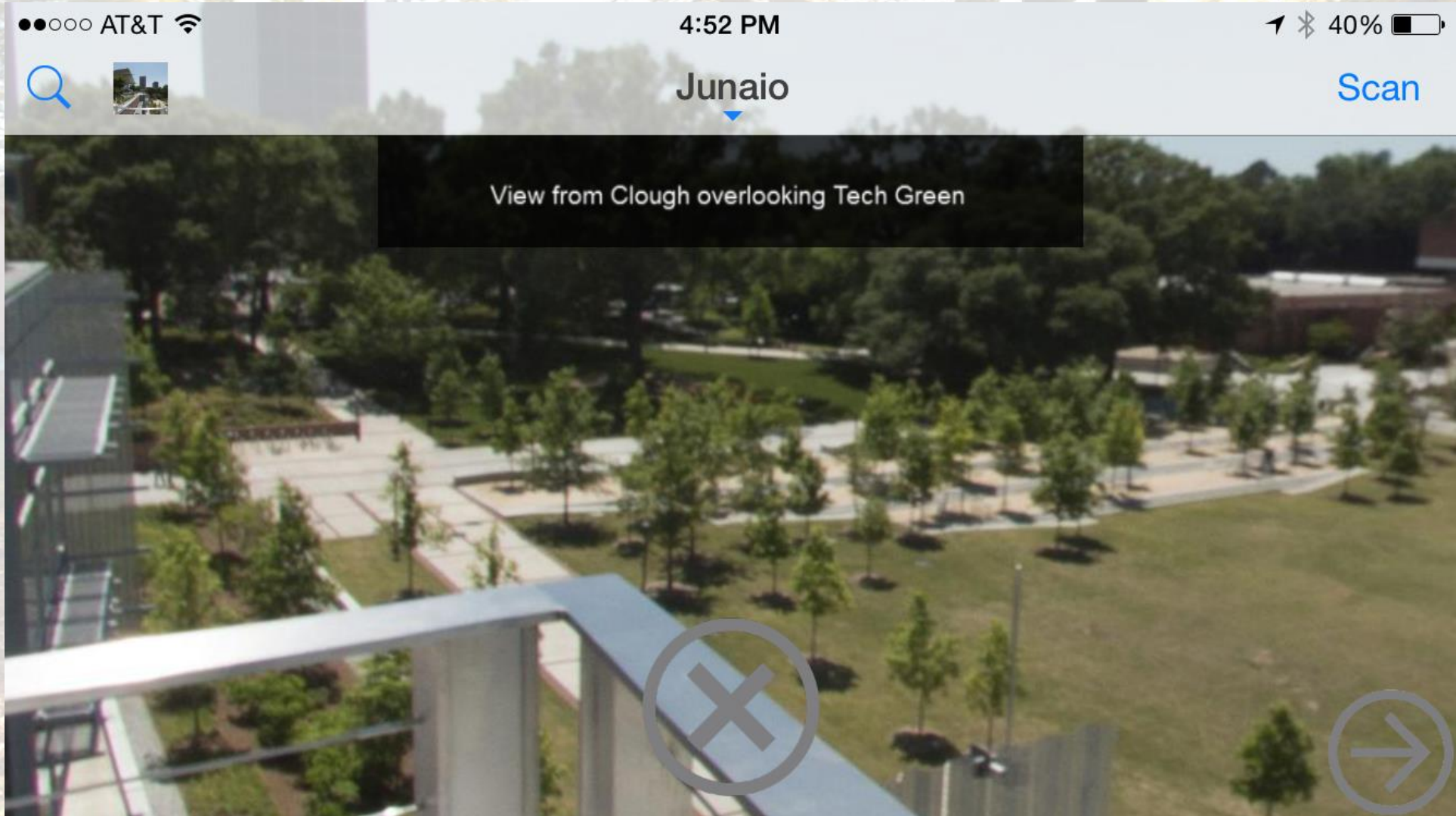
 The Purdue Arboretum



Augmented Reality App

In development - CoA/CGIS - Digital Building Lab

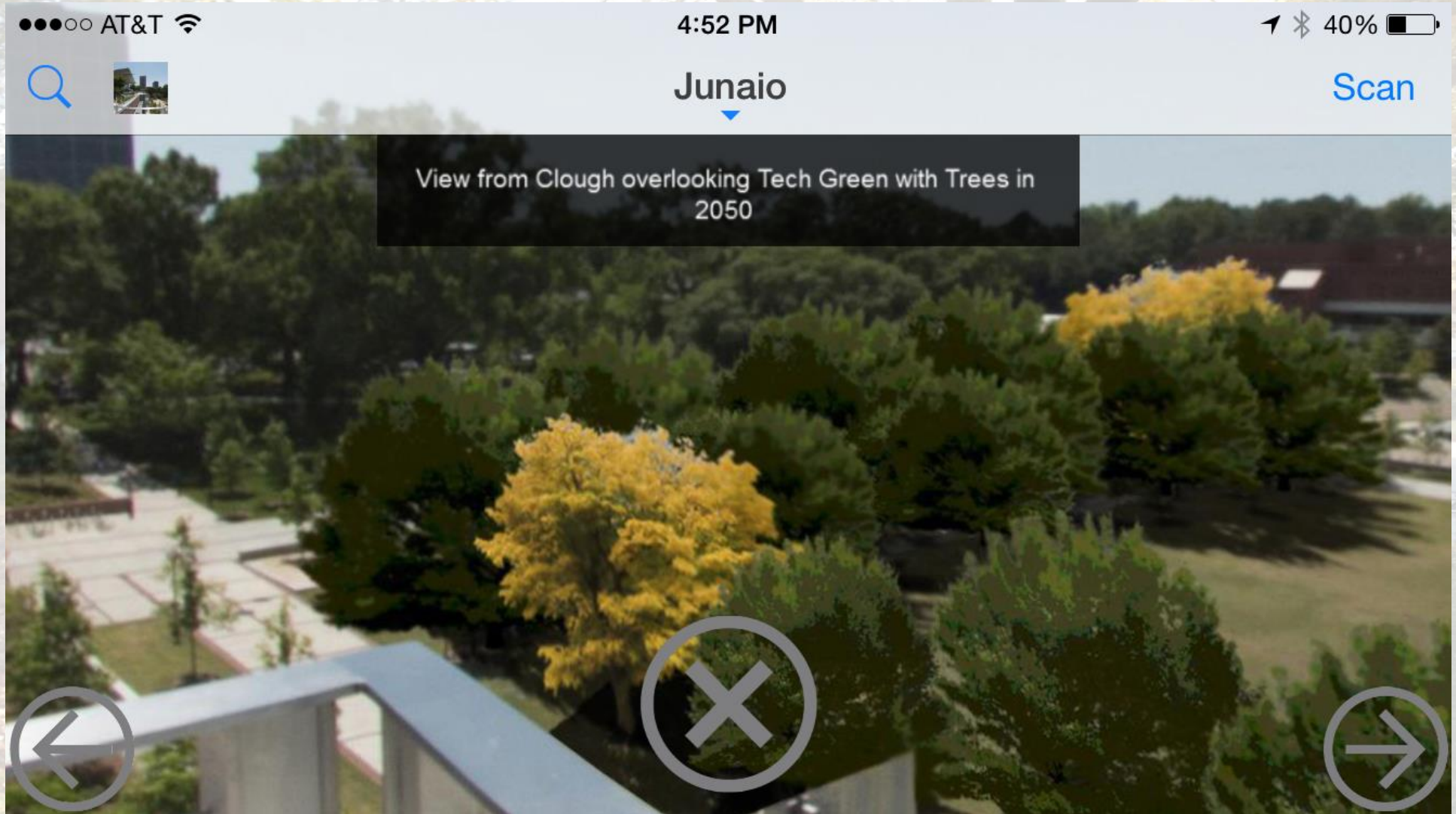
View of Tech Green today



Augmented Reality App

In development - CoA/CGIS - Digital Building Lab

View of Tech Green Trees in approximately 50 years



AR App Experience


A screenshot of an AR application interface overlaid on a street scene. The interface includes a status bar at the top with AT&T, signal strength, time (1:50 PM), location (Junaio), and battery (88%). Below the status bar are search and location icons, and a 'Scan' button. A distance slider is set to 0.2mi. The main view shows several tree identification overlays with labels and distances: 'Shumard oak' (143ft), 'Eastern redbud' (150ft), 'elm spp' (462ft), and 'Flowering dogwood' (145ft). Each overlay features a green tree icon and a semi-transparent background.

AT&T 1:50 PM 88%
Junaio Scan
0.2mi
Shumard oak 143ft
Eastern redbud 150ft
elm spp 462ft
Flowering dogwood 145ft

Select trees for performance information



AT&T 1:53 PM 87%

 Southern magnolia

132ft

Tree Number: 1562
Tree Condition: Good
Total Height: 58 ft
Diameter: 22.9 in
Leaf Biomass: 159.15 lb
Carbon Storage: 2112.56 lb
Gross Carbon Seq: 71.98 lb per year
Structural Tree Value: 5101 \$
Avoided Runoff: 118.76 cubic feet per year
Botanical Name: *Magnolia grandiflora*

[View Image](#)

[Route](#)

Close

AT&T 1:53 PM 87%



Navigation icons: back, forward, share, refresh, close



Living Learning Laboratory

Research/Teaching opportunities

- **Heat Island Effect – Canopy coverage (CoA)**
- **Stormwater Runoff Calculations (CGIS/CoA, CoE)**
- **Leaf Biomass (CGIS – CoA)**
- **Bee research – Bee Campus USA (COS – Jennifer Leavey)**
- **Augmented Reality (CGIS – Digital Building Lab)**
- **GIS/Planning (CGIS/CoA – Siva)**
- **Environmentalism & Eco-criticism LMC 3308 (Yanni Loukissas)**
- **The Urban Forest, EAS 2803 HPC (Monica Halka)**
- Energy use in adjacent buildings
- Phytoremediation (Using plants to clean soils)
- Biodiversity
- Pollution Reduction
- Carbon Sequestration
- Others...

Model Support with Eco Updates

i-Tree Eco is constantly evolving:

- Eco v6 is currently in beta and appears to be compatible with the tools developed and discussed
- A 2016 update will move away from MS Access and will require modifications to the tools
- i-Tree Eco is being used to support Urban FIA which may result in a more robust DBMS (and additional changes to the tools)





FGDBs and ArcGIS Online

Somewhat Related:

- File geodatabases (and other enterprise level DBMS) provide support for domains
- Domains are an integral component of ArcGIS Online and the use of ESRI Collector
- Urban Forestry South has also developed a domain package that illustrates typical (or example) urban forest inventory data collection



Acknowledgement

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