

# i-Tree Overview

**Assessing the value of urban trees**



# Today's Session



- Introduction
- Urban Forests in Context
- What is i-Tree: An Overview
- i-Tree Components & Tools
- Choosing the Correct i-Tree Tool
- Demo of i-Tree Software



# **i-Tree Overview**

**Assessing the value of urban trees**

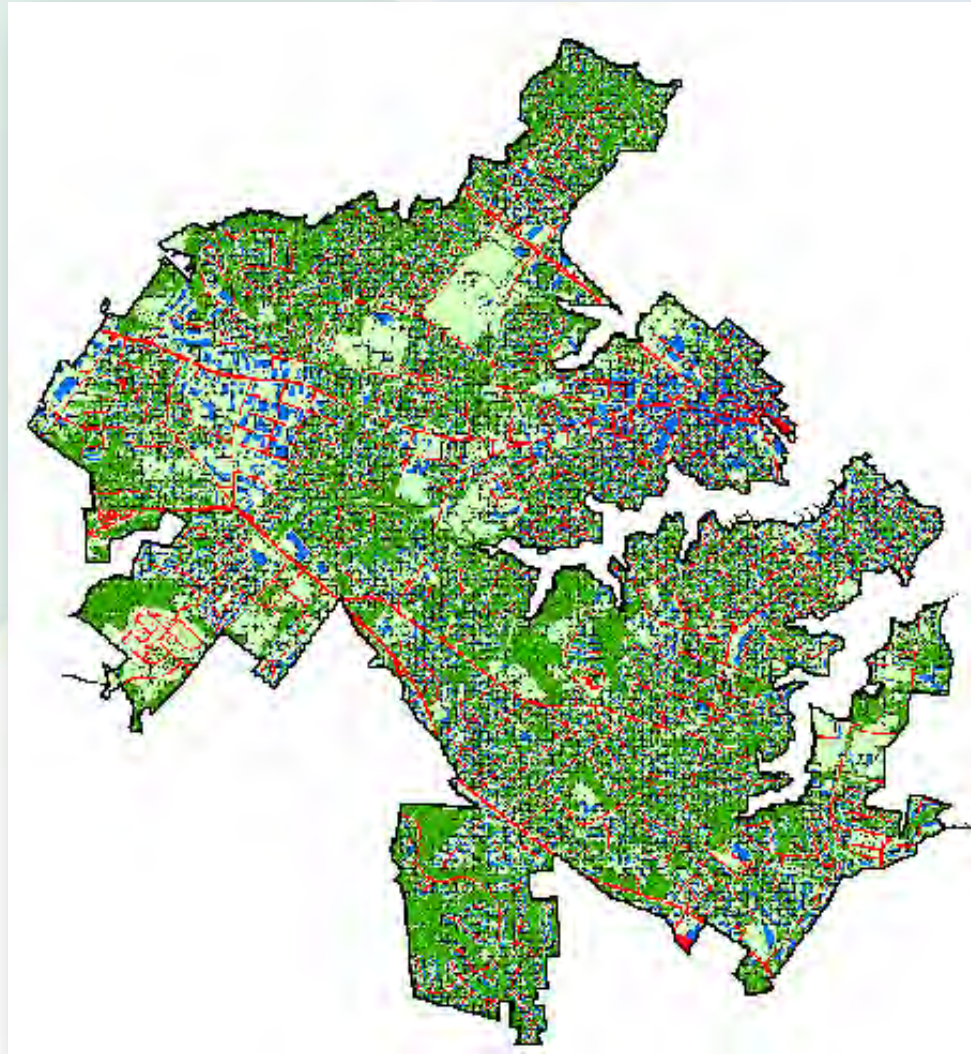


**[www.unri.org/research-documents](http://www.unri.org/research-documents)**

# Urban Forests & Tree Canopy



# Urban Forests & Tree Canopy



Annapolis, MD

# Urban Forests & Tree Canopy



Brooklyn, NY

# Urban Forests & Tree Canopy



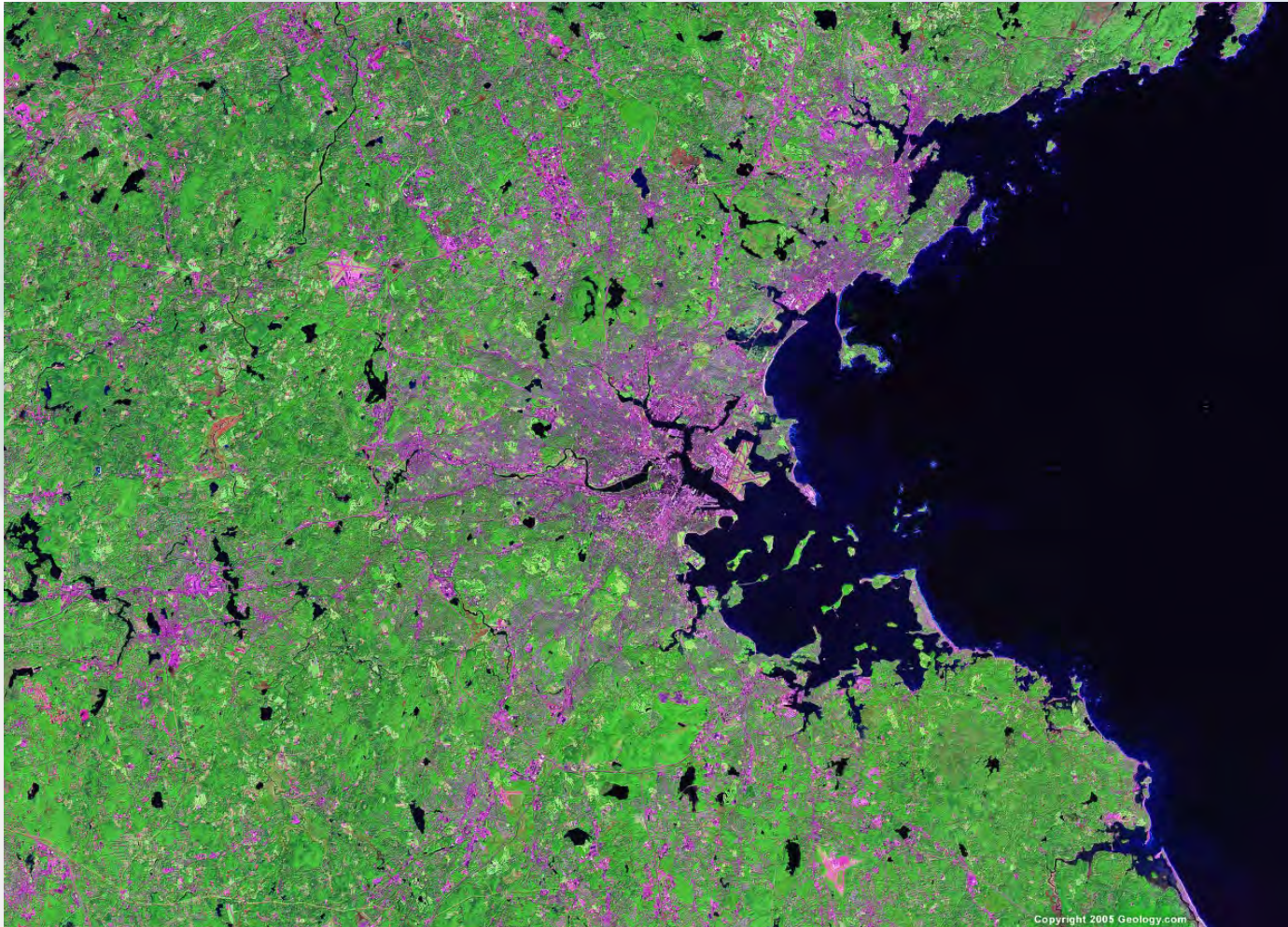
Chicago, IL

# Urban Forests & Tree Canopy



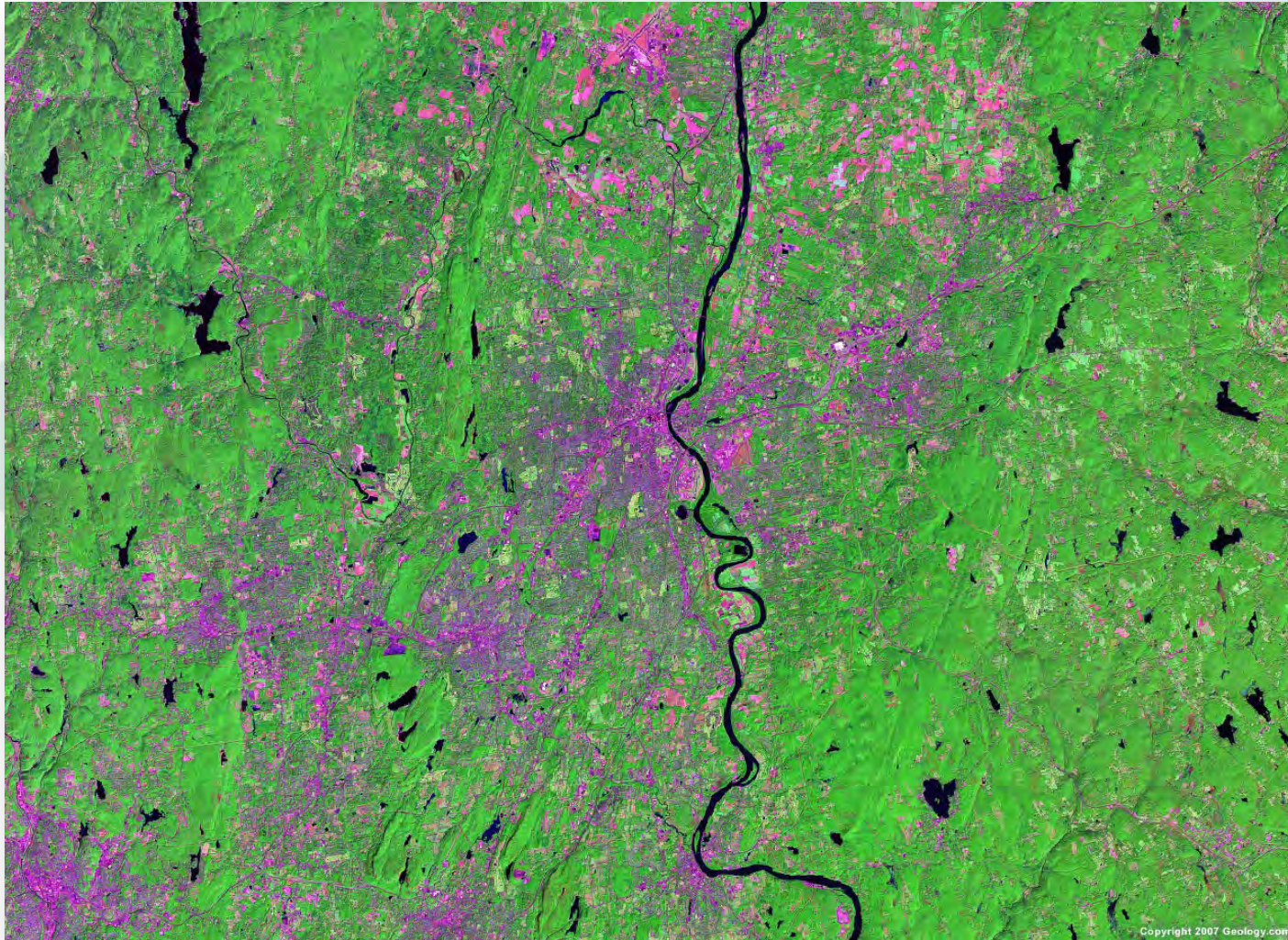
Detroit, MI

# Urban Forests & Tree Canopy



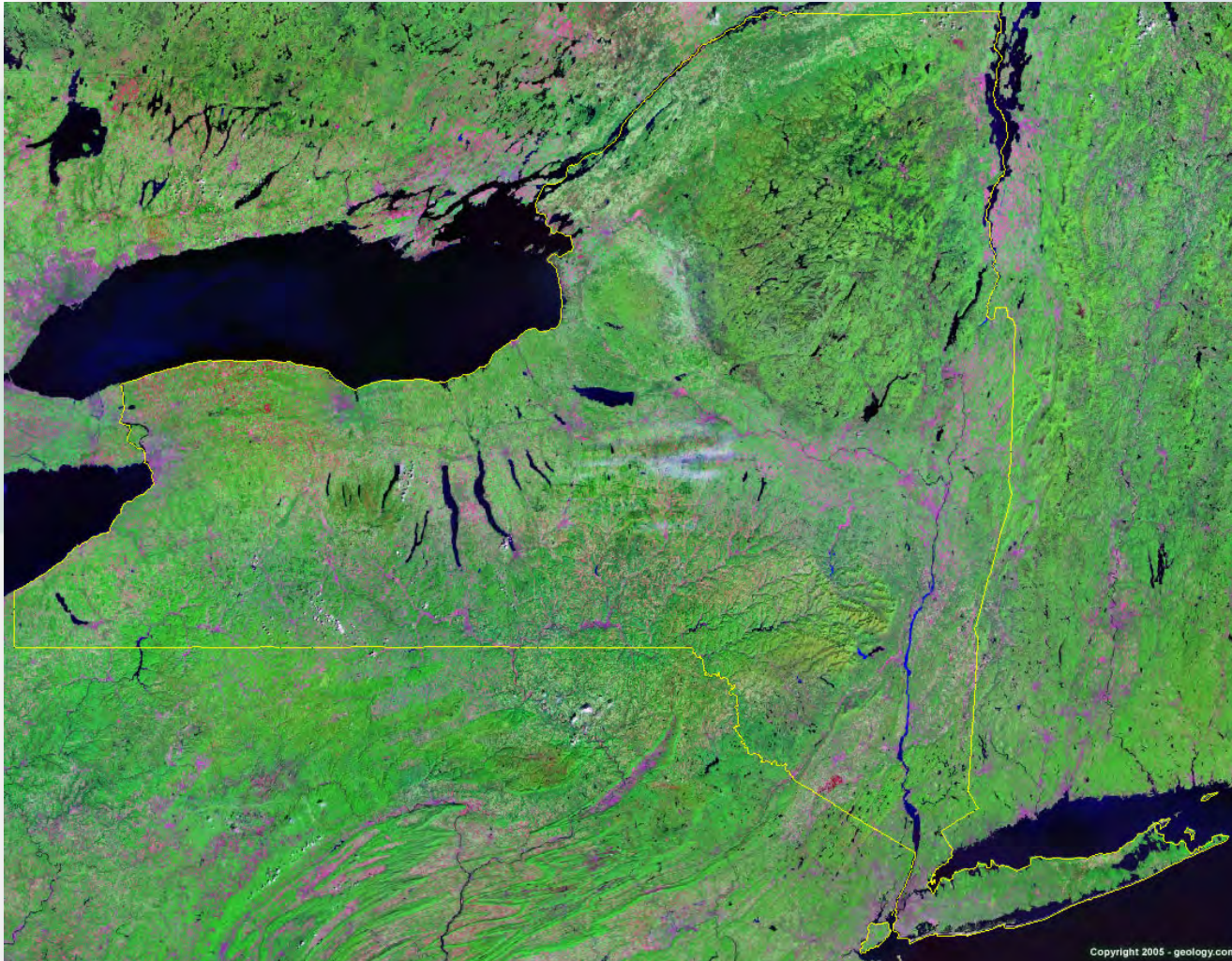
Boston, MA

# Urban Forests & Tree Canopy



Hartford, CT

# Urban Forests & Tree Canopy



New York

# Urban Forests & Tree Canopy



New York

# Urban Forests & Tree Canopy



Long Island, NY

# Urban Forests & Tree Canopy



# Urban Forests & Tree Canopy




# Urban Forests & Tree Canopy



# What is i-Tree?



 *A suite of software tools to assess urban vegetation and their ecosystem services and values*



*Initial Release Components*



*i-Tree is a  
Cooperative  
Initiative*



# Public-Private Partnership



🌳 USDA Forest Service



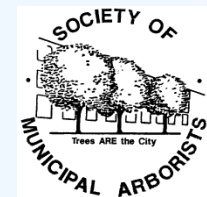
🌳 Davey Tree Expert Co.



🌳 National Arbor Day Foundation



🌳 Society of Municipal Arborists



🌳 International Society of Arboriculture

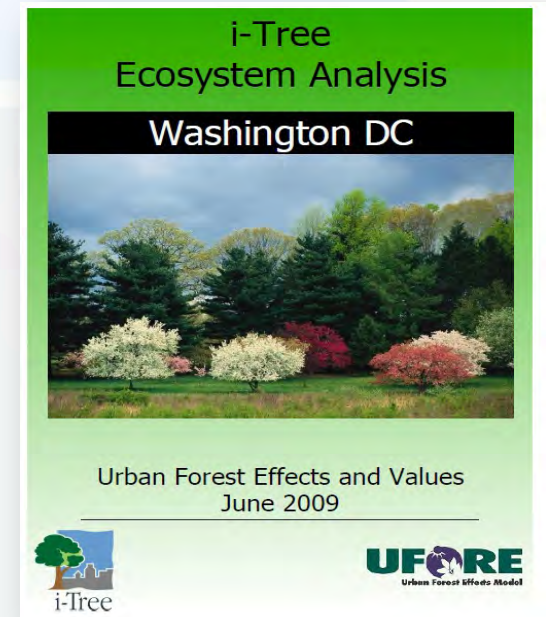


🌳 Casey Trees



# Goals

- ✿ Simple and low-cost tools and methods to aid in urban forest planning and management
- ✿ Complete process – start to finish



# Assessing Tree Populations

## i-Tree assesses:

- 🌳 Structure
- 🌳 Function
  - Energy use
  - Air pollution
  - Carbon
  - VOC emissions
- 🌳 Value
- 🌳 Management needs
  - Pest risk
  - Tree health
  - Exotic/invasive spp.

### I. Tree Characteristics of the Urban Forest

The urban forest of Washington DC has an estimated 2,043,000 trees with a tree cover of 29.6 percent. Trees that have diameters less than 6-inches constitute 56.7 percent of the population. The three most common species are American beech (14.60 percent), Red maple (6.43 percent), and Boxelder (6.17 percent).

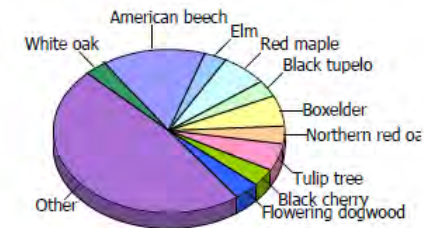


Figure 1. Tree species composition in Washington DC

Among the land use categories, the highest tree densities occur in Forest followed by Ag./Water/Wetlands and Developed, open. The overall tree density in Washington DC is 128 trees / hectare (see Appendix III for comparable values from other cities).

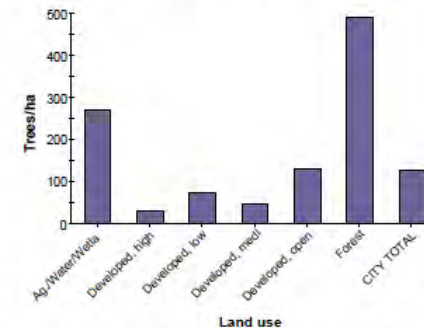


Figure 2. Number of trees/ha in Washington DC by land use

# The Foundation: Local Data

**Local Sample or  
Inventory**

**Local information:**

- 🌳 Weather
- 🌳 Pollution
- 🌳 Environmental  
variables

**Hourly simulations**



# Benefit-Based Approach



Strategic Management  
& Advocacy



Comprehensive  
Value



Environmental  
Services



Structure

# Conserving Energy



Image courtesy of the Center for Urban Forest Research

# Improving Air Quality



Image courtesy of the Center for Urban Forest Research

# Reducing Atmospheric Carbon Dioxide



# Reducing Stormwater Runoff

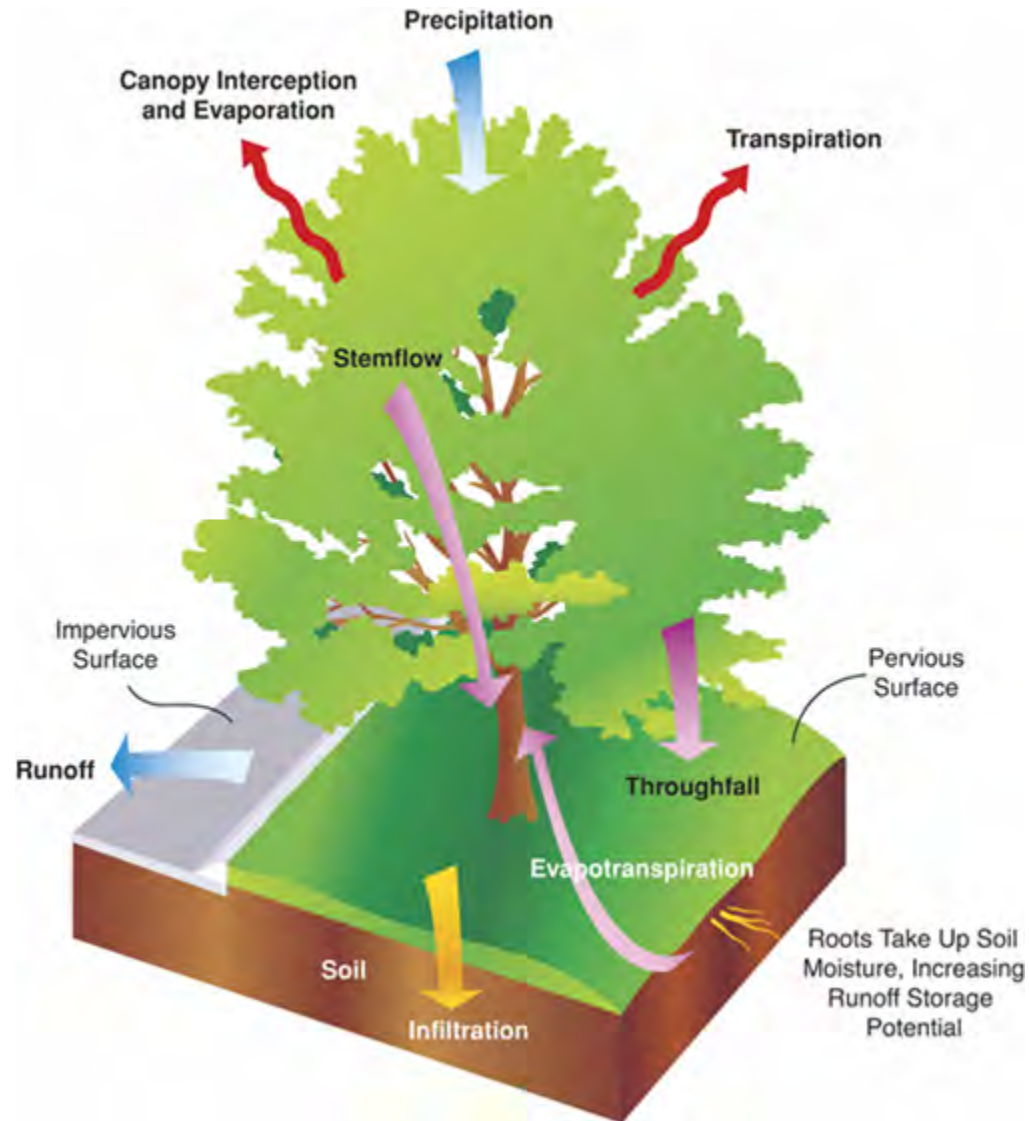


Image courtesy of the Center for Urban Forest Research

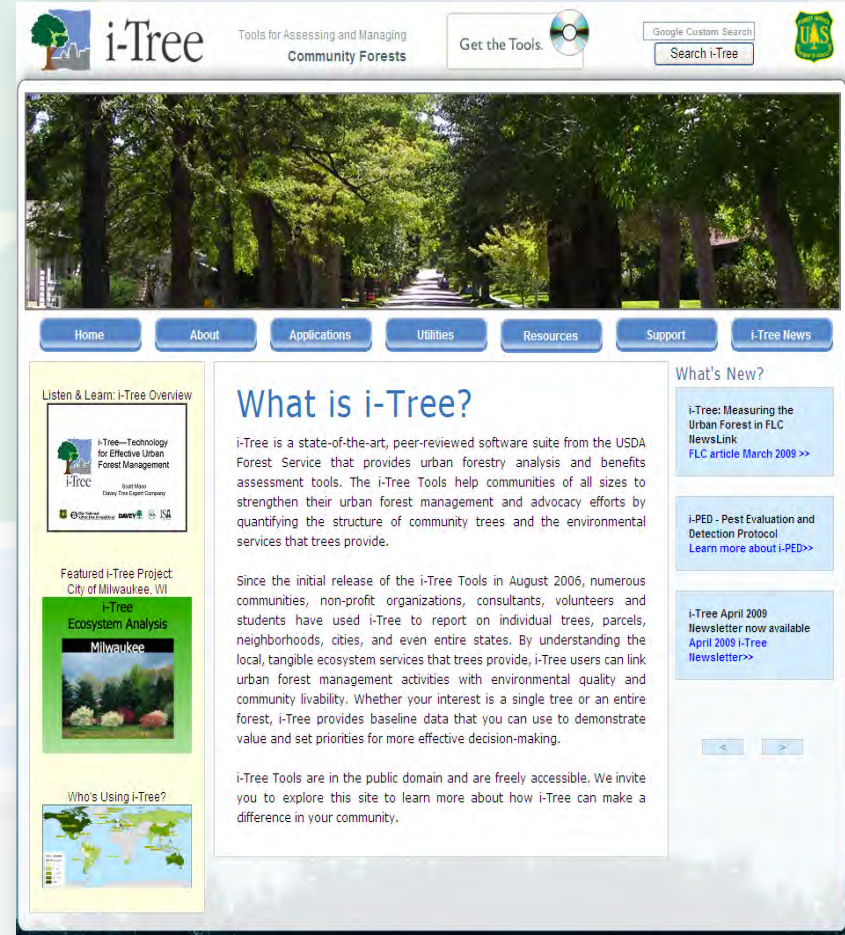
# i-Tree is...



## Development, Dissemination, Support, & Refinement

- **Credible, USDA FS peer-reviewed tools**
- **Public Domain Software**
- **Accessible**
- **Technical Support**

***“Putting USFS Urban Forest science into the hands of users”***



# What's being used?





# i-Tree Use



Program distribution increasing about 25% per year



Distributed to over 90 countries

# i-Tree Use



Friday, November 14, 2008 | Modified: Monday, November 17, 2008

## NFL favors proven strategies for a green Super Bowl

Tampa Bay Business Journal - by [Alexis Muellner](#) Editor

[Print](#) [Email](#) [Reprints](#) [RSS Feeds](#) [Add to Del.icio.us](#) [Digg This](#) [Comments \(1\)](#)

### Real carbon impacts

To that end, for the first time at a Super Bowl, the U.S. Forest Service is implementing in Tampa a public domain software monitoring system called i-Tree that it developed with Kent, Ohio-based Davey Tree Expert Co. The software, its components and the data it collects, is expected to do a far more accurate job of monitoring the carbon footprint of the tree-planting efforts than current systems offer.





## Maybe Only God Can Make a Tree, but Only People Can Put a Price on It

- **Climate change**
- **Storm water mgt.**
- **Pollution mitigation**
- **Energy conservation**
- **Carbon strategies**
- **Public health issues**



- **Economic development**
- **Green job creation**

# Greater Public Scrutiny



The United States Conference of Mayors

Release #2: December 8, 2008

## MAINSTREET ECONOMIC RECOVERY

Community Development, Green Jobs, Transit, Streets/Highways, Airports, Amtrak, Water, Schools, Housing, Public Safety

**"Ready to Go"**

Jobs and Infrastructure Projects

**AMERICA'S MAYORS** Report to the Nation on Projects  
to Strengthen Metro Economies and Create Jobs Now

Mansel A. (Manny) Diaz  
Mayor of Miami  
President

Tom Cochran  
CEO and Executive Director



THE UNITED STATES CONFERENCE OF MAYORS

*"Instead of spending money planting trees on a causeway, we should fix the bridge on the causeway," ...*

--Senator Tom Coburn (R-OK)

# Using technology to tell your story?



Credit: Waldo Nilo

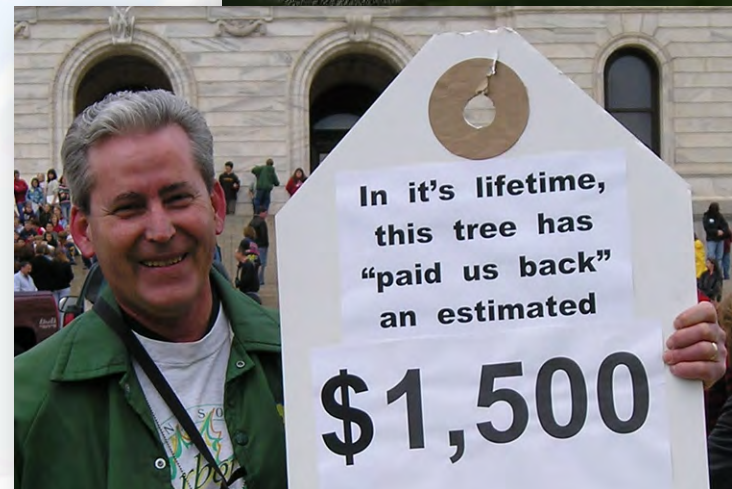


# i-Tree: Demonstrating That Trees Pay Us Back!



## Street Tree Benefits in Minneapolis:

- 🌳 \$6.8 million in energy savings
- 🌳 \$9.1 million in reduced storm water runoff
- 🌳 \$7.1 million increase in property value
- 🌳 \$1 million improvements to air quality



Monday, November 2nd, 2009



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YOU ARE HERE: [HOME](#) / [CITY HALL](#) / PARK LANE TREES GET REPORT CARDS; SOME QUESTION PROGRAM

## Park Lane trees get report cards; some question program

3



The City of Kirkland has given each tree along Park Lane a report card and some of them are not doing so well. The report cards state that the city is "working to restore, enhance

# How do we communicate the value of community trees?



🌳 ***“Shame on you City of Kirkland! Government has too much money if we can afford to grade trees!”***

**PARK LANE TREE INVENTORY**

**TREE REPORT CARD**

Tree Number: 415  
Species: Norway Maple  
Diameter: 17.8"

**A**

Grade Definition: *Shame on you*  
A(Retain) B(Retain/Monitor) C(Monitor) F(Remove/Replace)

Tree Criteria:

- Vigor: Very Good
- Structure: Good
- Health: Good
- Impact on other trees: *infrastructure* restricted soil
- Long term viability: Good
- Notes: Damage to sidewalk, curb, etc.

Working to restore, enhance and protect the City of Kirkland's Tree Assets

Tour of Park Lane Trees with City Urban Forester  
Tuesday October 27<sup>th</sup> (8:30 am – 9:15 am). Meet at Park Lane and Lake Street

Phase I Implementation Plan  
9:15 am – 10:15 am, Zeek's Pizzeria (124 Park Lane)

For more information, contact Karl Page 425-587-3011 kpage@co.kirkland.wa.us

*City of Kirkland!  
Government Has  
Too Much Money  
If we  
can Afford to  
Grade  
Trees!*

# Pittsburgh's Urban Forest



*City of Pittsburgh, Pennsylvania  
Municipal Forest Resource Analysis*

April, 2008



**\$2.94 in  
benefits for  
every \$1 spent**

*Benefit Summary for  
Pittsburgh's Street Trees*

<b>+ Benefits</b>	<b>Total (\$)</b>
 Energy	\$1,205,133
 CO2	\$35,424
 Air Quality	\$252,935
 Stormwater	\$334,601
 Aesthetic/Other	\$572,882
<b>➡ Total Benefits</b>	<b>\$2,400,975</b>

# Chestertown, MD: linking technology with policy



Energy	\$31,280
Carbon	\$7,760
Air quality	\$8,287
Stormwater	\$83,413
Property	\$103,020
Total annual benefits	\$223,750



# Milwaukee i-Tree Eco Assessment



## EAB Structural Impacts:

**17.4% Canopy Loss**

**\$221 Million structural damage  
(citywide)**

## EAB Functional Impacts:

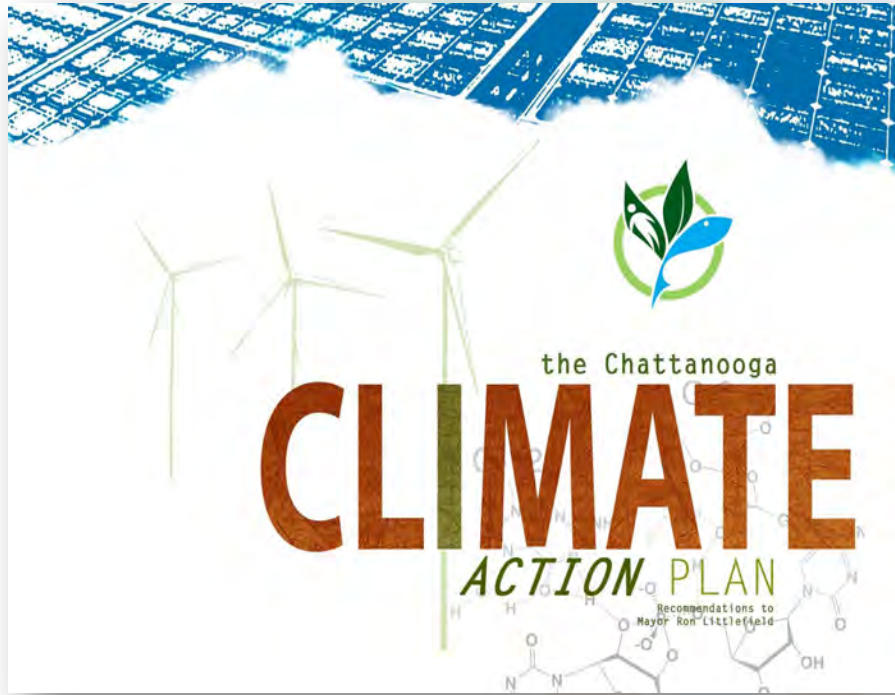
- 🌳 \$243,785 less pollutant removal
- 🌳 \$138,000 less energy savings (cooling costs)
- 🌳 \$2.6 million reduction in storm water benefits (1996 study)



# Milwaukee Ecosystem Assessment



# Chattanooga, Tennessee



**GOAL: Reduce global warming pollution levels to 7 percent below 1990 levels by 2012.**

*U.S. Conference of Mayors, Climate Protection Agreement*

## CLIMATE ACTION PLAN: RECOMMENDATIONS



### URBAN AND REGIONAL FORESTS



**FIGURE 35: INCREASE URBAN FOREST**

Estimated GHG Reduction (metric tons)	Estimated Cost	Estimated \$ Savings	
63	\$	★	

**FIGURE 36: MODIFY LANDSCAPE ORDINANCE TO RETAIN TREES**

Estimated GHG Reduction (metric tons)	Estimated Cost	Estimated \$ Savings	
501	NOT CALCULATED	★	

# Detailed, Species Specific Data



**Table 13. Net Atmospheric CO<sub>2</sub> Reduction by Chattanooga's Street Trees—City-Managed Population Only**

Species	Sequestered (lb)	Sequestered (\$)	Net Total (lb)	Total (\$)	SE	% of Total Tree Numbers	% of Total \$	Avg. \$/tree					
hackberry	3219030	24,190.30											
flowering dogwood	660577	4,954.33											
black cherry	1132151	8,491.13											
mimosa	259225	1,944.19											
crapemyrtle	220719	1,655.39											
slippery elm	783416	5,875.62	4041645	30,312.34	(±5,126)	10.8	12.1	1.69					
boxelder	1476852	11,076.39	798960	5,992.20	(±1,285)	6.9	2.4	0.52					
red maple	1237812	9,283.59	1398996	10,492.47	(±2,031)	4.5	4.2	1.41					
sweetgum	398331	2,987.48											
sugar maple	622267	4,666.90											
white oak	1757987	13,184.90	322339	2,417.54	(±592)	3.9	1.0	0.37					
eastern red cedar	222030	1,665.22											
tree of heaven	262374	1,967.80	311476	2,336.07	(±712)	3.6	0.9	0.39					
callery pear	390189	2,926.42											
eastern white pine	740275	5,552.06											
silver maple	1798692	13,490.19	-78831	-397	-594.21	369853	2,773.89	2089317	15,669.88	(±4,113)	2.2	6.2	4.38
Yoshino flowering cherry	14991	112.41	-150	-89	-6.29	37049	277.87	85741	643.06	(±450)	2.1	0.3	0.18
Virginia pine	361588	2,711.91	-13722	-382	-105.78	110879	831.59	458363	3,437.72	(±802)	2.1	1.4	1.00
loblolly pine	361584	2,711.87	-13722	-382	-105.78	126057	945.42	587090	4,403.18	(±1,340)	2.0	1.8	1.34
shortleaf pine	367183	2,753.87	-10485	-344	-81.22	90842	681.31	447194	3,353.96	(±1,031)	1.9	1.3	1.08
eastern redbud	137464	1,030.98	-4388	-333	-35.41	36638	274.78	169380	1,270.35	(±566)	1.8	0.5	0.42
willow oak	1099667	8,247.50	-91351	-307	-687.43	270410	2,028.07	1278419	9,588.14	(±2,492)	1.7	3.8	3.46
winged elm	143218	1,074.14	-2294	-255	-19.12	24976	187.32	165645	1,242.34	(±452)	1.4	0.5	0.54
chestnut oak	373189	2,794.18	-2019	-240	-225.32	20161	1,521.00	847187	6,353.90	(±2,085)	1.3	2.5	2.85
water oak	635487	4,766.25	-32257	-243	-243.75	131119	998.39	736106	5,520.80	(±1,663)	1.3	2.2	2.52
white ash	412970	3,097.27	-13419	-228	-102.35	115432	865.74	514755	3,860.66	(±1,250)	1.2	1.5	1.87
Chinese elm	572308	4,292.31	-11933	-221	-91.15	96271	722.03	656425	4,923.19	(±1,945)	1.2	2.0	2.47
southern red oak	647183	4,853.81	-44188	-213	-333.01	227365	1,675.99	826246	6,996.89	(±1,621)	1.2	2.5	3.22
black tupelo	215956	1,619.67	-3443	-195	-21.56	8395	629.07	25773	1,801.60	(±45)	1.1	0.4	1.08
Other street trees	6645139	49,838.54	-281435	-3901	-2,140.02	1835412	13,765.59	8195215	61,464.11	(±6,623)	21.2	24.5	1.75
Citywide Total	27620224	\$207,151.70	-1110142	-18399	-\$8,464.06	6969860	\$52,273.95	33461542	\$250,961.59	(±30,808)	100.0	100.0	\$1.51

➤ Average CO<sub>2</sub> reduction = 200 lbs

➤ Average tree maintenance costs = \$3.46

✓ Cost of CO<sub>2</sub> reduction = \$35 per ton

✓ 25% of Carbon emissions offset by municipal trees

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✓ Cost of CO<sub>2</sub> reduction = \$35 per ton

✓ 25% of Carbon emissions offset by municipal trees

# Springfield Massachusetts June 1, 2011 Tornado



# Springfield Massachusetts

## June 1, 2011 Tornado



# INFORMATIONAL BRIEF

3.0

June 23, 2011

Kipling Street  
East Forest Park  
Springfield, MA



## Tornado Damage Quick Facts Impacts on Springfield's Street Trees

On June 1, 2011 a series of three tornadoes ripped through Western Massachusetts, and included the second strongest tornado ever recorded in Massachusetts, with wind speeds estimated at 136 to 165 mph, according to the National Weather Service. The most severe tornado was the EF-3, on the Enhanced Fujita Damage Classification Scale, that carved a half-mile-wide path for 39 miles from Westfield to Charlton, killing three people and injuring 200. In Springfield, the tornadoes impacted city's South End, Six Corners, East Forest Park and Sixteen Acres neighborhoods.

In the neighborhoods of Springfield affected by the storms, damage to the street trees was extensive, destroying or severely many of the public trees growing in these areas. A team of US Forest Service and City of Springfield personnel conducted a preliminary review of the streets in these neighborhoods, and an initial summary of the storm impacts was developed.

A preliminary review of the storm damage to Springfield public street trees follows here:

- 87 miles of the 540 total miles of city streets were impacted by the storms;
- 16.1 % of Springfield's streets showed some damage to the public trees growing on them;
- Approximately 1,340 of the 3,830 streets trees, growing in the impacted areas, were destroyed or severely damaged, necessitating removal;
- Immediate impacts include the reduction of rainwater interception by 2,444,252 gallons;
- Reduced storage of 7,220,361 pounds of carbon;
- Approximately 331,232 pounds of sequestered CO<sup>2</sup> has been lost.

For more information please contact:



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City of Springfield  
Assistant City Forester  
[arsherman@eco.umass.edu](mailto:arsherman@eco.umass.edu)



# i-Tree Streets Analysis of Springfield Tornado Impact Zone



# Annual Loss in Benefits of Springfield's Street Trees



## Annual Benefits of Impact Zone Street Trees

Benefit	Quantity	Impact Zone Value	Loss Value
<b>Energy Saved</b>			
Electricity (MWh)	360.6	\$18,393	\$4,598
Natural Gas (therms)	129,018.6	\$85,439	\$29,903
<b>Total (\$)</b>		<b>\$103,832</b>	<b>\$34,501</b>
<b>Carbon Dioxide</b>			
CO <sub>2</sub> Sequestered (lbs)	946,377	\$3,123	\$1,093
CO <sub>2</sub> Released (lbs)	-244,714	-\$808	-\$283
CO <sub>2</sub> Avoided (lbs)	1,086,259	\$3,585	\$1,255
<b>Total (lbs, \$)</b>	<b>1,787,922</b>	<b>\$5,900</b>	<b>\$2,065</b>
<b>Air Quality</b>			
Avoided pollutants* (lbs)	4954	\$21,451	\$7,508
Deposited pollutants** (lbs)	4264	\$22,958	\$8,035
BVOC emitted (lbs, \$)	-1,140	-\$2,634	-\$922
<b>Total (lbs, \$)</b>	<b>8,078</b>	<b>\$41,775</b>	<b>\$14,621</b>
<b>Storm Water</b>			
Rainfall intercepted (gal)	6,983,576	\$55,872	\$19,555
<b>Aesthetic/Other</b>			
Added Property Value		\$140,569	\$49,199
<b>TOTAL VALUE</b>		<b>\$347,948</b>	<b>\$121,782</b>

\*NO<sub>2</sub>, SO<sub>2</sub>, VOC, PM<sub>10</sub> \*\*O<sub>3</sub>, NO<sub>2</sub>, PM<sub>10</sub>, SO<sub>2</sub>



# INFORMATIONAL BRIEF

July 7, 2011

Arcadia  
Boulevard  
Springfield, MA



## Tornado Damage Quick Facts

### Impacts on Springfield's Urban Forest

On June 1, 2011 a series of three tornadoes ripped through Western Massachusetts, and included the second strongest tornado ever recorded in Massachusetts, with wind speeds estimated at 136 to 165 mph, according to the National Weather Service. The most severe tornado was the EF-3, on the Enhanced Fujita Damage Classification Scale, that carved a half-mile-wide path for 39 miles from Westfield to Charlton, killing three people and injuring 200. In Springfield, the tornadoes impacted city's South End, Six Corners, East Forest Park and Sixteen Acres neighborhoods.

In the neighborhoods of Springfield affected by the storms, damage to the urban forest canopy was extensive, destroying or severely many of the trees growing in these areas. A team of US Forest Service and City of Springfield personnel conducted a preliminary review of the streets in the impacted neighborhoods, and utilized i-Tree modeling software to analyze the impacts of the storms on the urban forest, and an initial summary of the damage was developed.

A preliminary review of the storm damage to Springfield's urban tree canopy follows here:

- Based on initial estimates, over 13,000 trees were destroyed or severely damaged;
- Immediate impacts include the reduction of rainwater interception by over 7.5 million gallons per year;
- Reduced storage of over 30 million pounds of carbon annually;
- Approximately 1.4 million pounds of sequestered CO<sub>2</sub> has been lost.

For more information please contact:

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## i-Tree Canopy Analysis of Springfield Tornado Zone



# i-Tree Canopy Analysis of Springfield Tornado Zone

- Over 13,000 trees were destroyed or severely damaged;
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# i-Tree Version 2014

## 5 New or Enhanced Tools





# i-Tree Design



i-Tree

Tools for Assessing and Managing  
Community Forests

Get the Tools.



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## i-Tree Benefit Calculator

1500 N Mantua St, Kent, OH 44240, USA

[Home](#)  
[Calculate another tree](#)

Overall Benefit

Storm Water

Energy

Air Quality

CO2

About Model

Stormwater Cooling Heating  
Air Quality CO2



**Breakdown of your tree's benefits**

Click on one of the tabs above for more detail

**This 21 inch Northern pin oak provides overall benefits of: \$163 every year.**

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations—a general accounting of the benefits produced by urban street-side plantings.

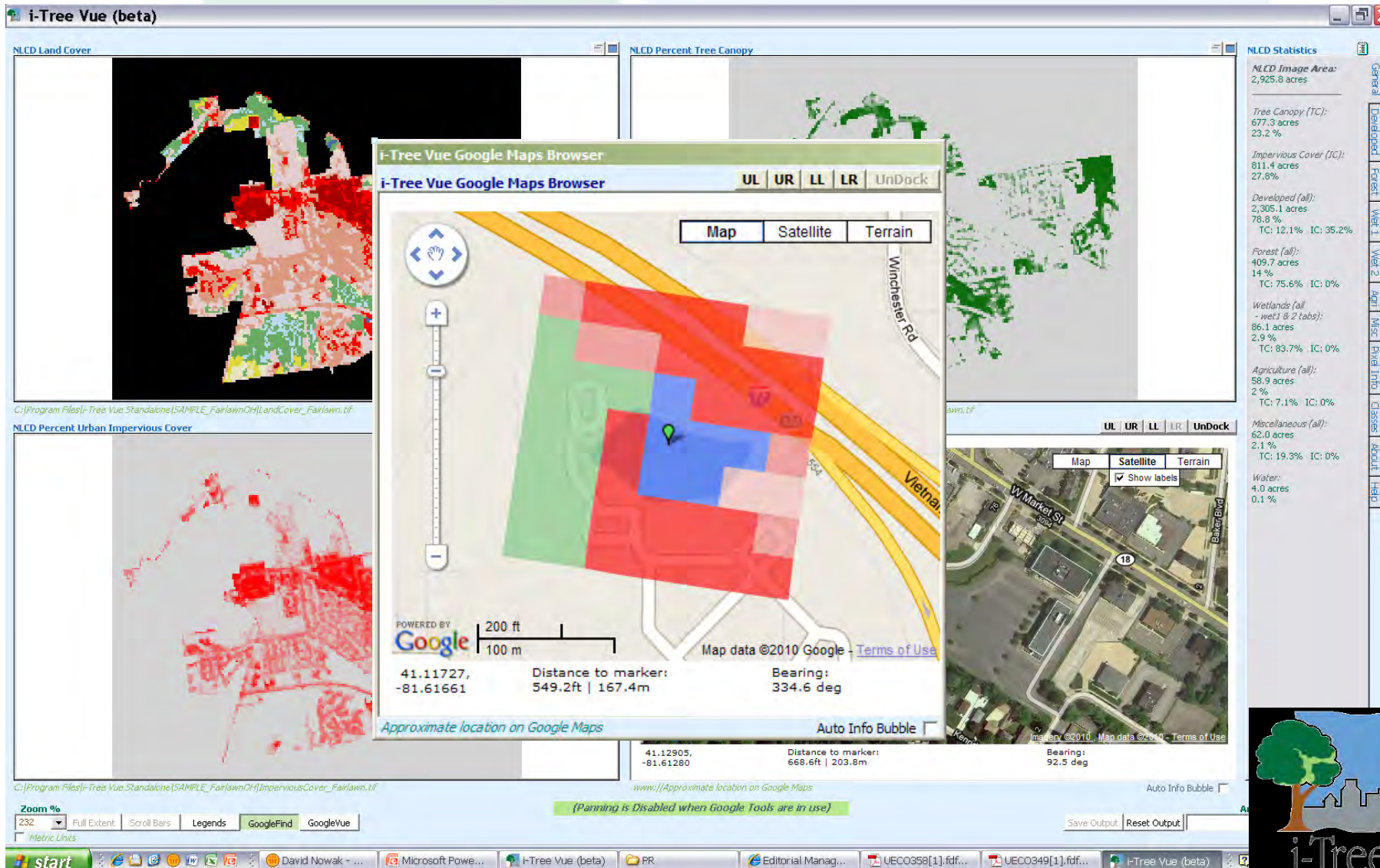
Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

**If this tree is cared for and grows to 26 inches, it will provide \$195 in annual benefits.**

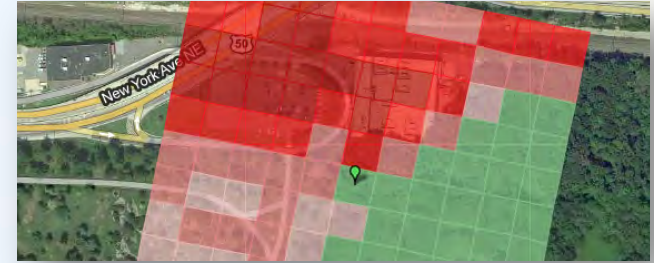
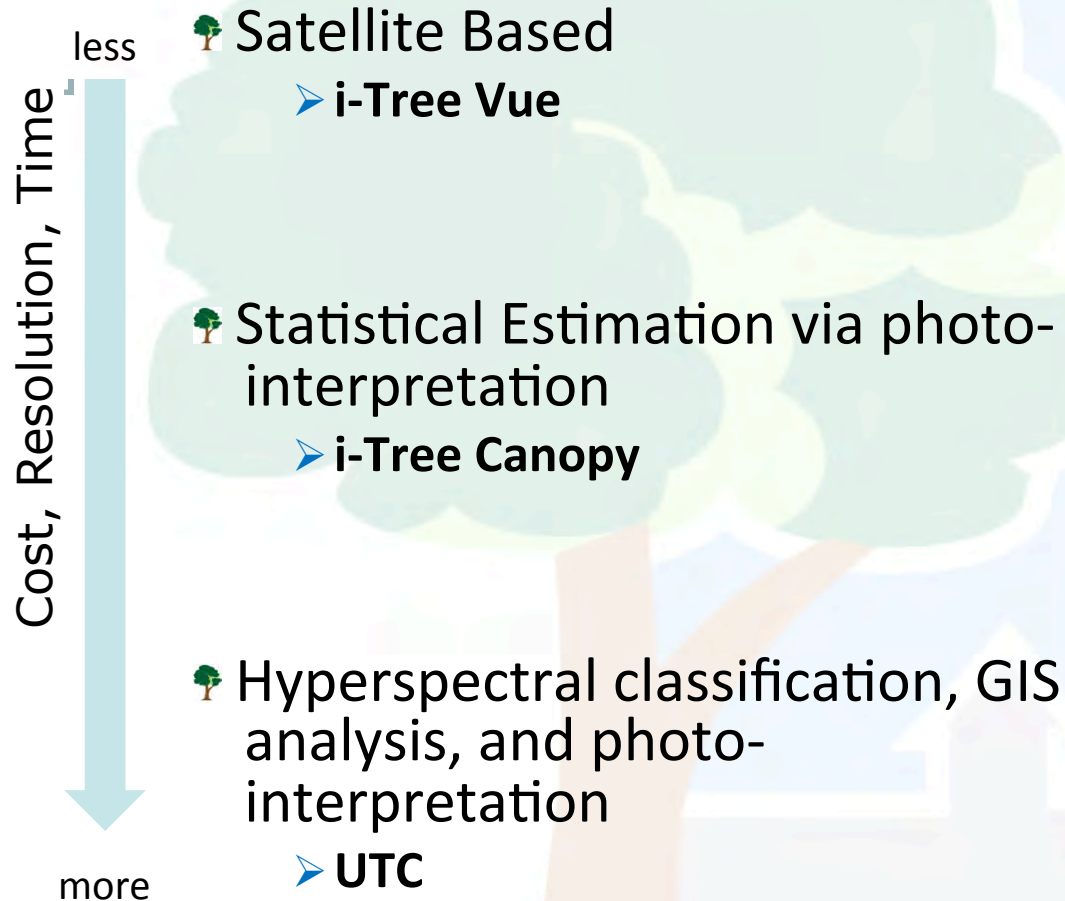


Northern pin oak  
*Quercus ellipsoidalis*

# Vue – Estimates Ecosystem Services from National Cover Maps and Google Maps



# Remote Sensing Canopy Assessment Tools



# i-Tree Canopy




i-Tree Canopy - Windows Internet Explorer provided by USDA Forest Service


http://dev.itreetools.org/canopy/index.php

File Edit View Favorites Tools Help


★ Favorites Get More Add-ons

i-Tree Canopy

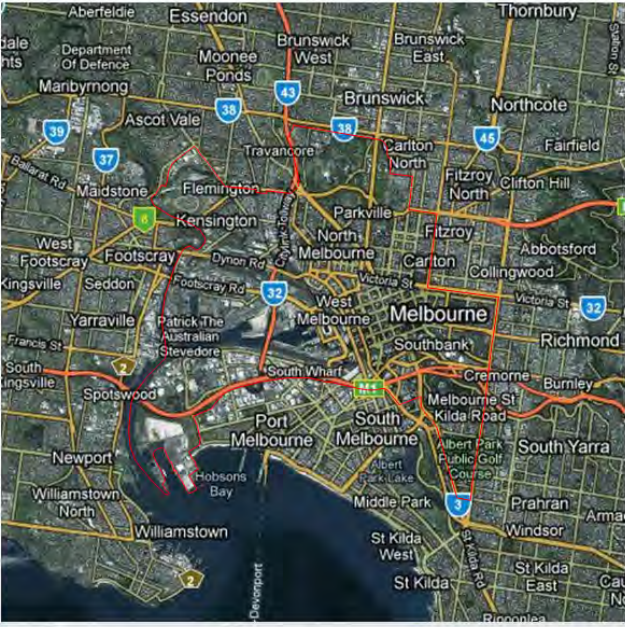
 **i-Tree** Tools for Assessing and Managing Community Forests

Get the Tools. 

Google Custom Search  
Username Password  
Forgot Username or Password? Search Login Register



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## i-Tree Canopy

Get started in three easy steps!

**One** Browse to your project area boundary GIS file. The file must be in ESRI Shapefile format and in lat/long coordinates.  
 ? Or

**Two** Configure the cover classes for your survey.  
 ?

**Three** Begin i-Tree Canopy Survey > ?

Been here before?  
Already started an i-Tree Canopy survey?  
Load it here and resume your work.  
 ?

More Information!

- With i-Tree Canopy, you can load a polygon boundary in ESRI Shapefile format on the map above and conduct a cover assessment for a project area.
- Collect data on your own cover classes of interest.
- 500-1000 survey points are suggested; the more points you complete, the better your assessment will be.

Done

start David No... i-Tree V... 2 Micr... Inter... Search Desktop 100% 12:04 PM

# Classify random points



i-Tree Canopy: Survey - Windows Internet Explorer provided by USDA Forest Service

http://dev.itreetools.org/canopy/survey.php

File Edit View Favorites Tools Help

Get More Add-ons

i-Tree Canopy: Survey

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Map Satellite

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Remember, the more points you survey, the lower your Standard Error, and the more precise your sampling will be. More points surveyed provide for a better estimation of forest canopy cover.

i-Tree Canopy

Percent Cover ( $\pm$ SE)


42.9  $\pm$ 24.7 57.1  $\pm$ 28.6

Id	Cover Class	Latitude	Longitude
1	Tree	-37.82930543236	144.91265730117
2	Tree	-37.81302356330	144.95401488007
3	Tree	-37.81913019363	144.97617933379
4	Non-Tree	-37.82964905605	144.98052520547
5	Non-Tree	-37.81840952395	144.97104739912
6	Non-Tree	-37.82188855427	144.94620800253
7	Non-Tree	-37.81882077	144.92805906653
8	Tree	-37.78606178656	144.94090887519

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Save Your Data

start David No... i-Tree V... 2 Micr... Inter... Search Desktop 100% 12:09 PM



# i-Tree

Tools for Assessing and Managing Community Forests


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## i-Tree Canopy

Percent Cover ( $\pm$ SE)

34.3	8.96	44.8	7.46	0.00	0.00	4.48
$\pm 5.80$	$\pm 3.66$	$\pm 6.08$	$\pm 3.34$	$\pm 0.00$	$\pm 0.00$	$\pm 2.59$

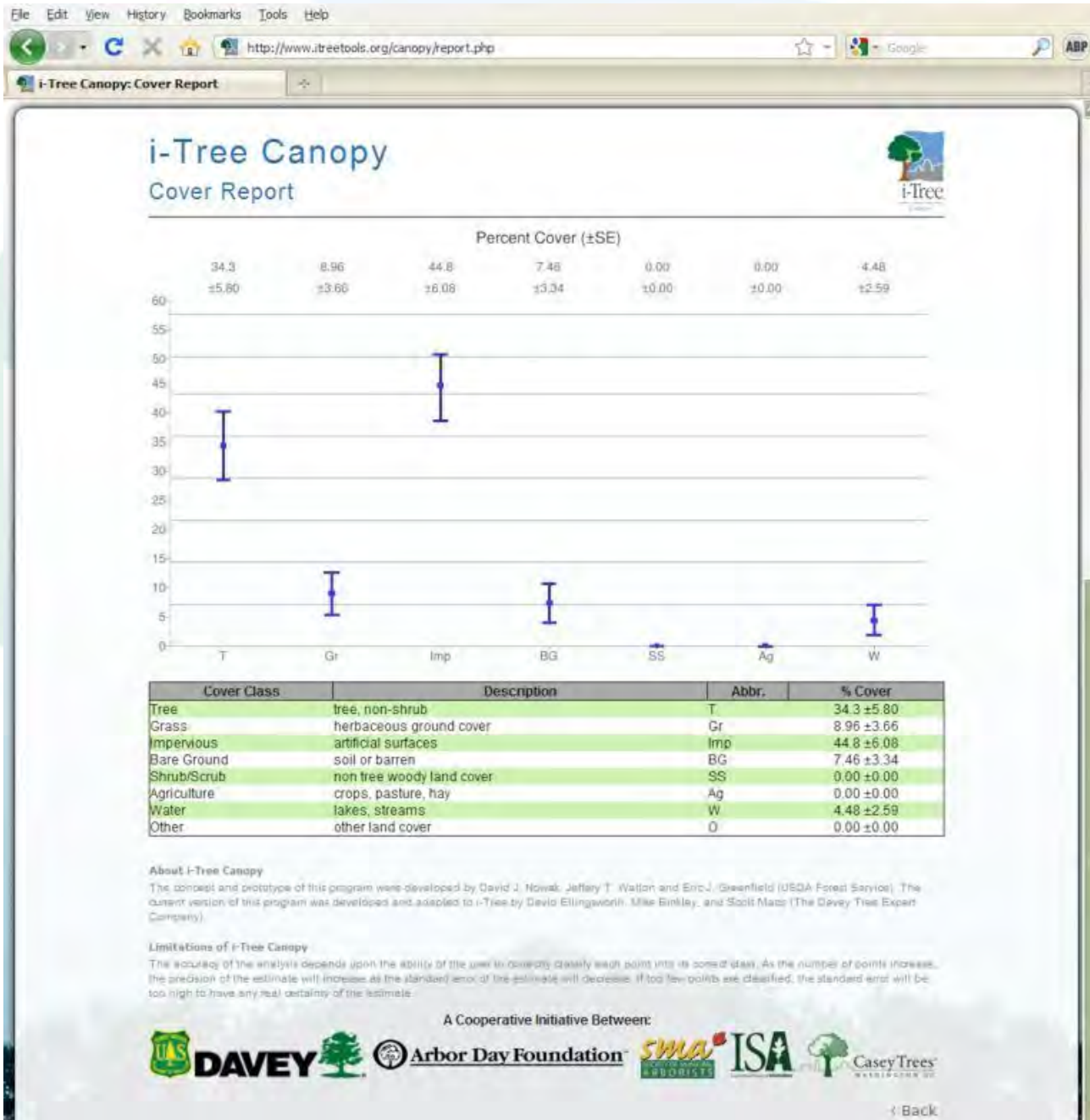


Id	Cover Class	Latitude	Longitude
61	Tree	38.902153927112	-76.965047428253
62	Water	38.923799096149	-77.110429223729
63	Tree	38.961324676131	-77.03983893727
64	Impervious	38.866540734234	-76.965398989474
65	Tree	38.888206252128	-76.951066339859
66	Grass	38.891553823381	-77.04287817671
67	Impervious	38.907230806429	-77.049487697045

Remember, the more points you survey, the lower your Standard Error, and the more precise your sampling will be. More points surveyed provide for a better estimation of Land Cover across your study area.

### Save Your Data

Save Early. Save Often. Don't lose your project data!



# Pest detection Protocol

## Component of Streets in i-Tree v.4.0

## Collect Pest & Disease

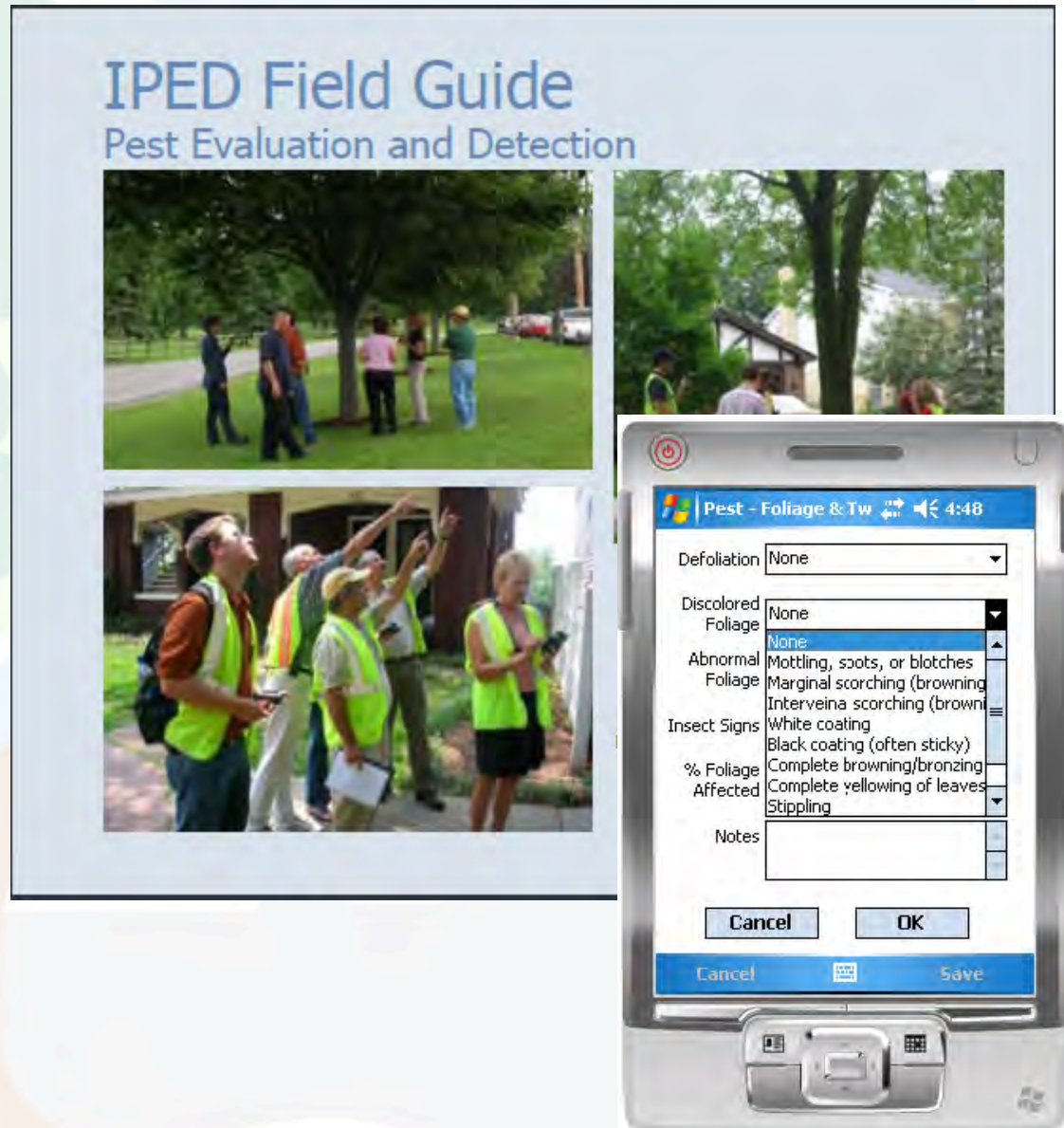
Signs

Symptoms

## Reports

Associated pest & diseases

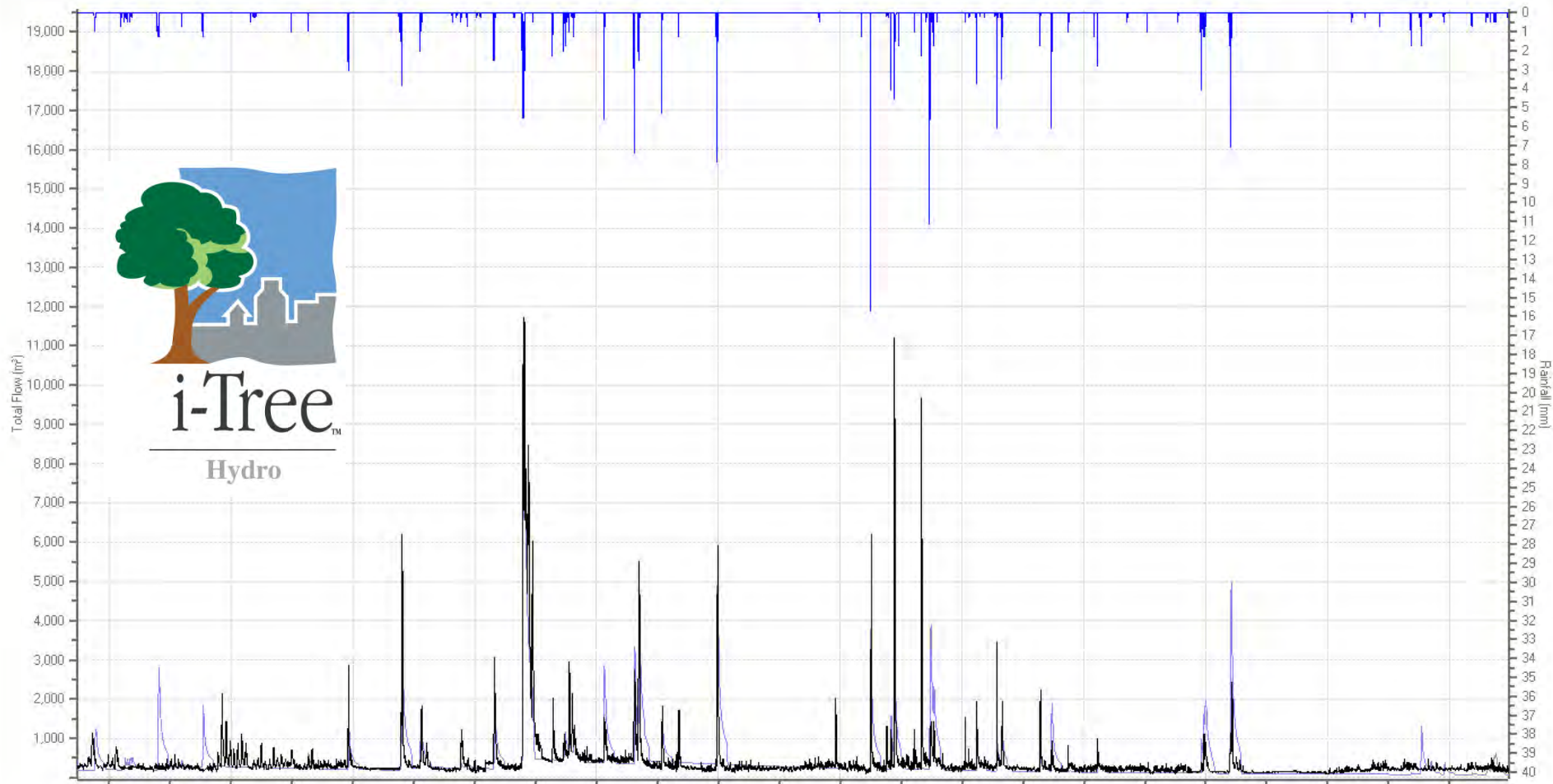
Trends/patterns



# i-Tree-Hydro



- 🌳 Separate GIS program
- 🌳 Calibrates against stream flow data



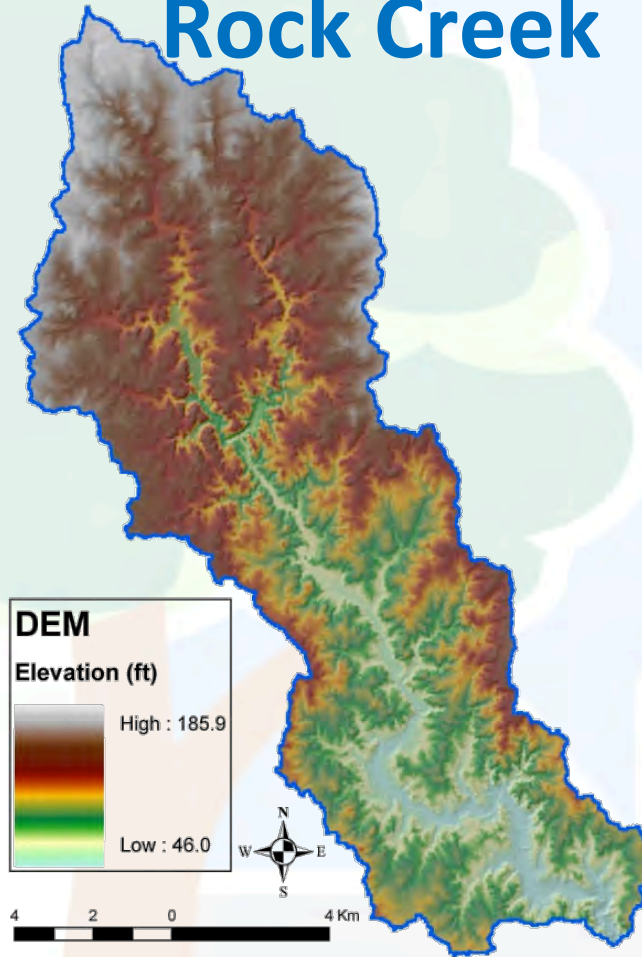


i-Tree™

Hydro



# Rock Creek

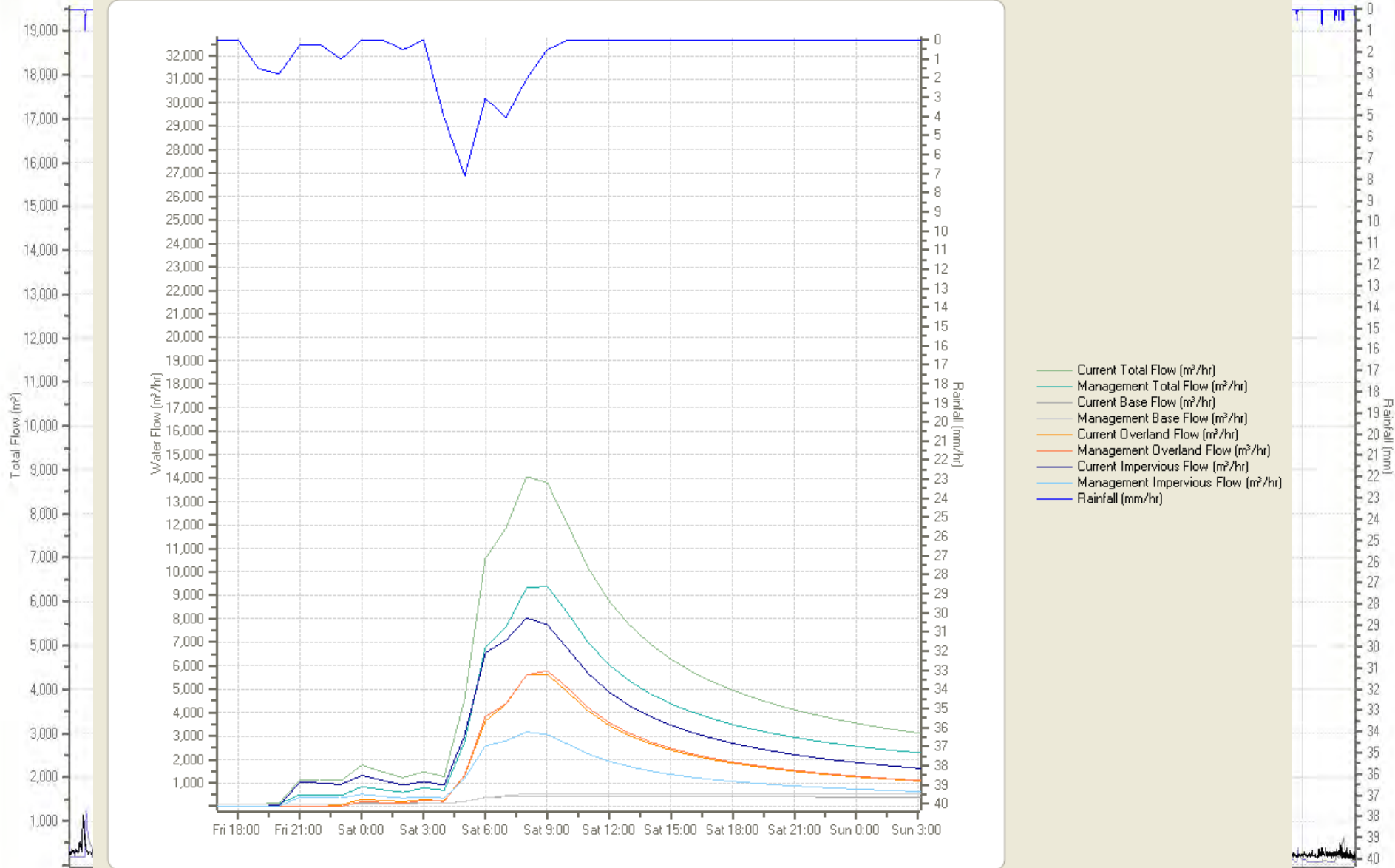


Watershed Area (m2)	161,653,500
Percent Impervious cover	15.8
Percent Tree Cover	27
Percent of Tree Cover over Impervious Area	10
Percent Water Cover	0.3
Average Tree Leaf Area Index (LAI)	3.5
Percent Shrub Cover	7.8
Percent Grass Cover	33.8
Percent Evergreen Trees	4.2
Percent Evergreen Shrubs	21
Shrub LAI	3.9
Leaf on Day	80
Leaf off Day	294

# Hydro Reporting



Current vs. Management Scenario



# i-Tree 5.0 Tools for Urban Forest Assessment

