



David J. Nowak
USDA Forest Service



Overview



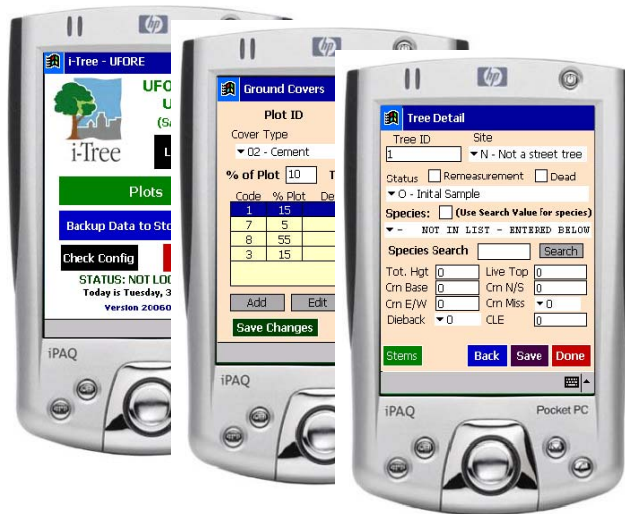
- 🌳 What is i-Tree Eco?
- 🌳 Background & Methods
- 🌳 Project Steps
- 🌳 Putting i-Tree Eco to work
- 🌳 Questions & Answers

Assessing Urban Tree Populations



i-Tree Eco assesses:

- Structure
- Function
 - ✓ Energy
 - ✓ 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).

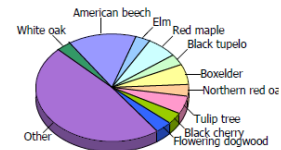


Figure 1. Tree species composition in Washington DC

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

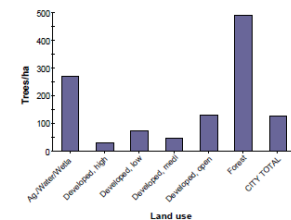
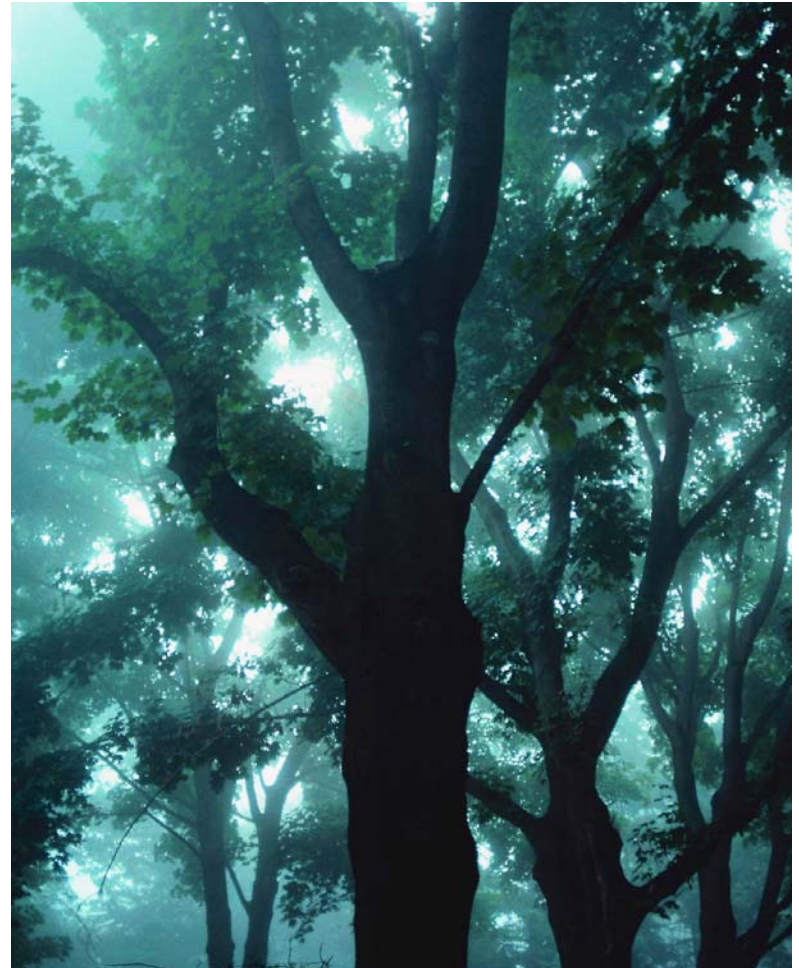


Figure 2. Number of trees/ha in Washington DC by land use

i-Tree Eco Helps You:

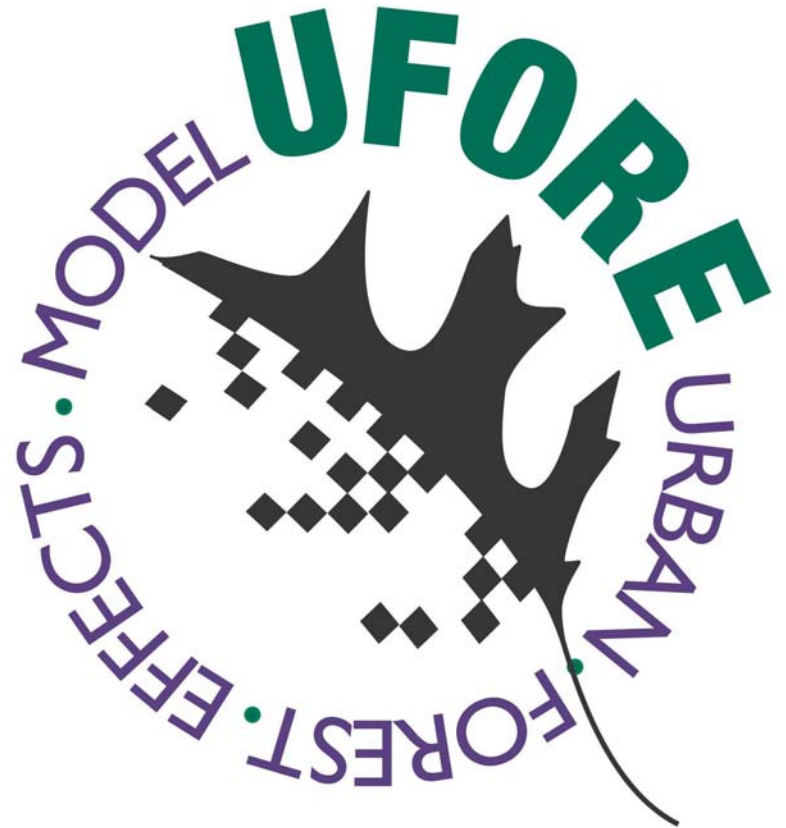
- 🌳 Determine magnitude and distribution of resource
- 🌳 Quantify ecosystem services and values
- 🌳 Improve planning and management
- 🌳 Empower advocacy
- 🌳 Link with environmental regulations
- 🌳 Monitor change



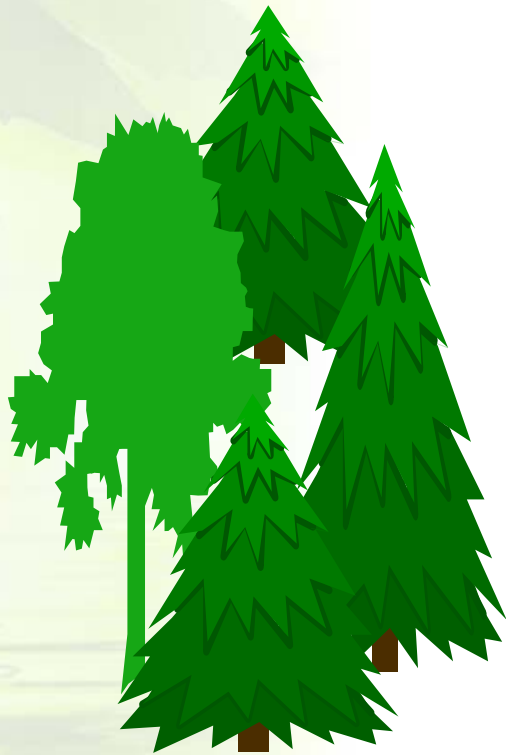
Background



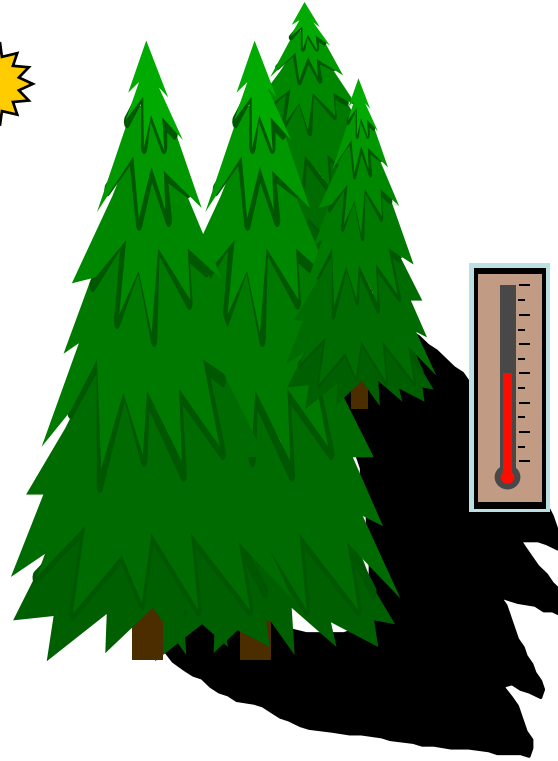
- 🌳 Originally developed as UFORE model in mid 1990s to assess urban forest impacts on air quality
- 🌳 Has expanded capabilities through the years



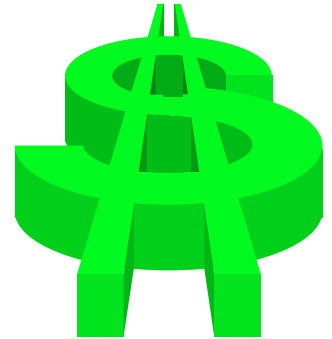
The Premise: Data Collection



Structure



Function



Value



The Foundation: Local Data

🌳 Sample or Inventory

🌳 Local information:

➤ Weather

➤ Pollution

➤ Environmental variables

🌳 Hourly simulations



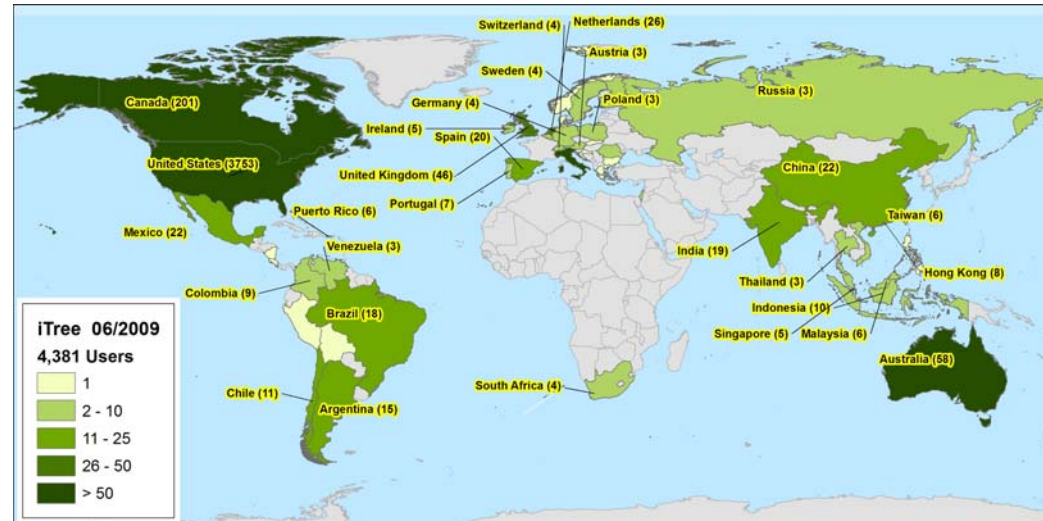
i-Tree Eco Use



Has been used worldwide in over 60 cities (9 countries)

Some limitations internationally:

- Need local pollution data
- No energy effects
- No structural value
- New species may need to be added
- Average growth rate needed



i-Tree Eco Methods - Structure

- 🌳 No. trees, species composition, tree sizes, tree condition
 - Direct measures, statistical estimates with standard errors
- 🌳 Leaf area
 - Formula based on species factors and crown measurements; adjusted based on crown missing
- 🌳 Leaf biomass
 - Converts leaf area to leaf biomass based on species conversion factors
- 🌳 Data can be stratified (e.g., land use)

i-Tree Eco Methods - Functions

Carbon

- Biomass equations (spp, dbh, ht)
- Adjusted downward for open-grown trees
- Annual growth based on dieback, competition and length of growing season

Air Pollution Removal

- Leaf area index, canopy cover by evergreen or deciduous; in-leaf season length
- Local hourly weather & pollution conc. (C) data
- O₃, SO₂, NO₂: multi-layer/big-leaf hybrid model
- PM, CO: average deposition velocity (Vd)

$$\text{Hourly Removal} = Vd \times C$$

i-Tree Eco Methods - Functions

Building Energy Use

- Based on work by McPherson and Simpson
- Tree size by distance and direction from building
- Average effects for region (heating and cooling)

VOC emissions (not reported)

- Local hourly weather data
- Species leaf biomass
- Genera specific emission factors adjusted by NCAR and EPA formulas based on hourly light intensity and temperature (BEIS approach)

i-Tree Eco Methods - Valuation

Air Pollution Removal

- National average externality values from literature (updated to 2007)
- Converting to EPA BenMap estimates

Carbon Storage and Sequestration

- Global externality estimates (Fankouser, 1994) = \$22.8/metric ton

Energy Use

- State average electricity and heating fuel costs (oil, wood, natural gas)

Structural Value

- CTLA formula

Project Equipment and Costs

- 🌳 Crew salary
- 🌳 Transportation
- 🌳 Project oversight (QA/QC, training)
- 🌳 Equipment
 - Aerial photographs and street map to locate plots
 - Clinometer
 - Diameter tape
 - Clipboard; data sheets, pens/pencils (or digital recorders-PDA)
 - 50/100 ft tape measure (or electronic measuring device)
 - Species ID guide
 - Compass
 - Camera (if taking pictures of plot)
 - Chalk/Flagging (to mark trees that have been measured in plots with many trees)

i-Tree Eco – General Project Steps



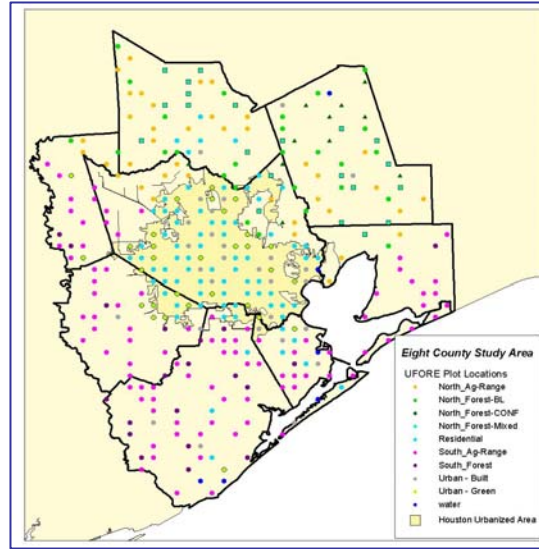
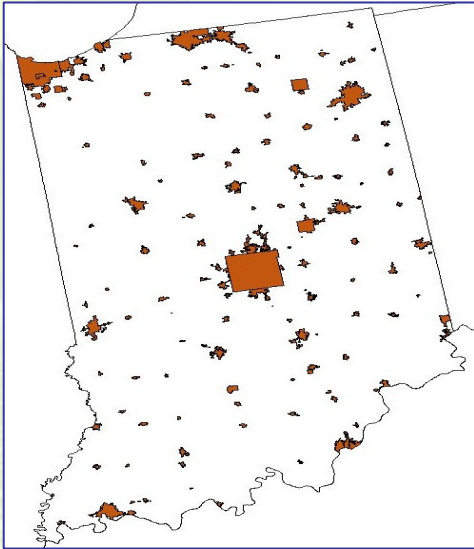
🌳 Urban forest assessment



Using i-Tree Eco






Step 1 - Determine Study Area



Using i-Tree Eco

Step 2 - Determine What Data to Collect

-  Sample or inventory?
-  Required core variables (spp, dbh)
-  Optional variables
 - Crown parameters
 - Tree health (dieback)
 - % Canopy Missing
 - Crown Light Exposure
 - Distance to buildings
 - Shrub data
 - Ground cover data



Tree = any woody vegetation, except vine, with a DBH \geq 1 in

Using i-Tree Eco



🌳 Step 3a – Determine number of plots

🌳 Typically 200 1/10 acre plots

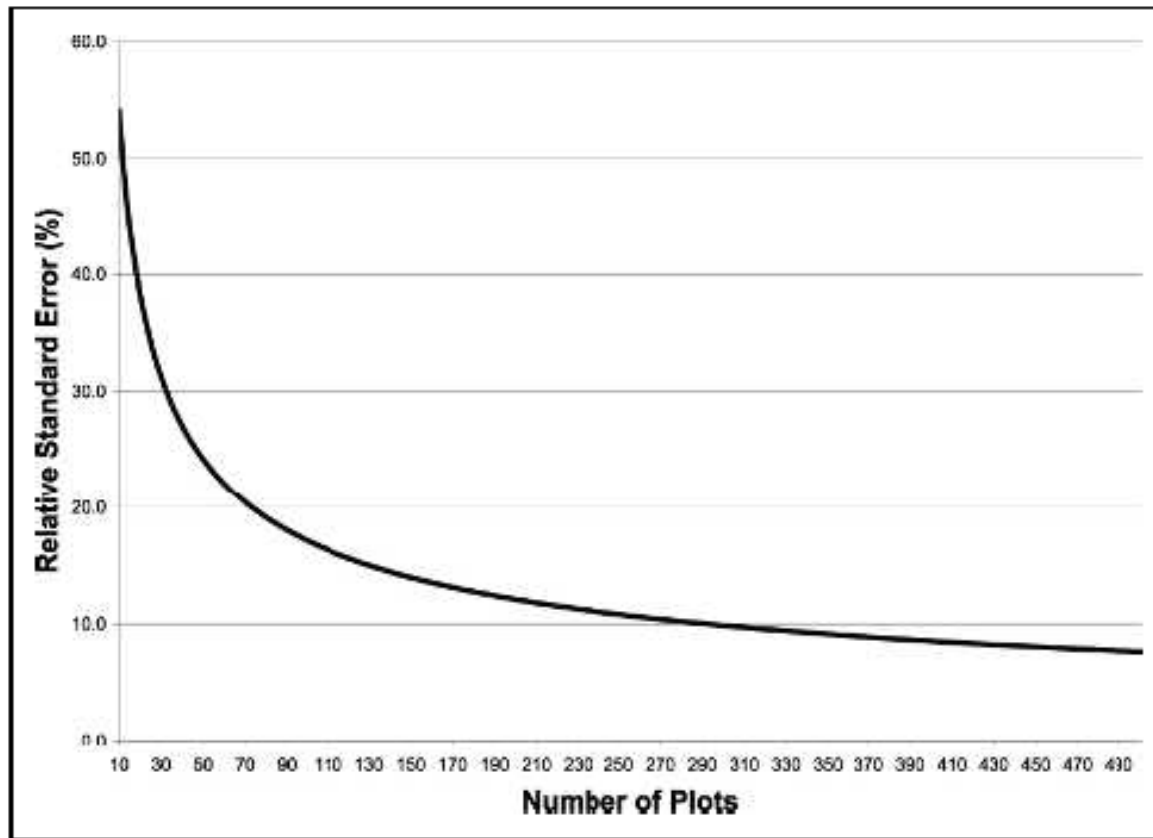
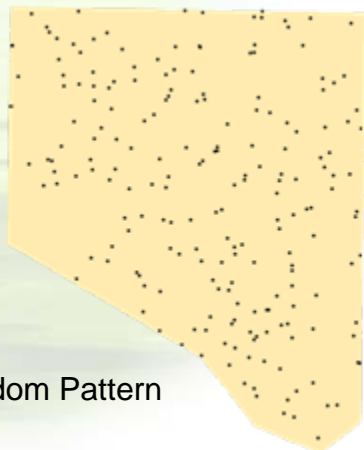
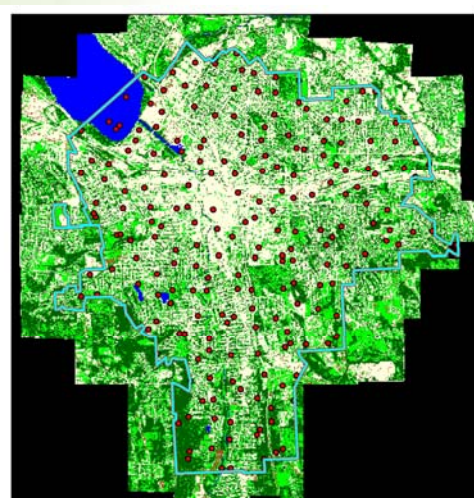


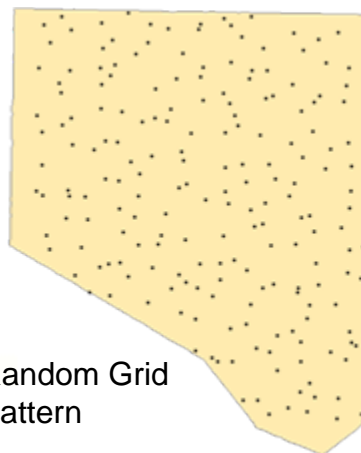
Figure 1. Estimated relative standard error ($SE/total \times 100$) of total number of trees based on varying number of total one-tenth acre (0.04 ha) field plots.

Using i-Tree Eco

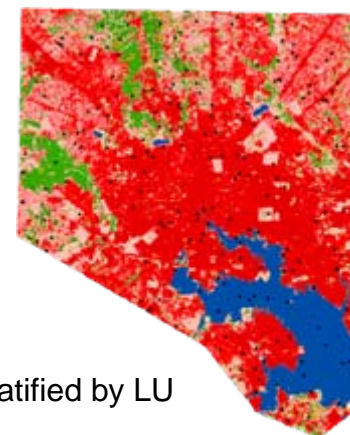
Step 3b– Lay Sample Points



Random Pattern



Random Grid
Pattern



Stratified by LU

Using i-Tree Eco



Step 4 – Set Up Project

Creating/Configuring inventories ...

Location

Location Name: Providence State: Rhode Island

Nation: United States of America County: Providence

Place: Providence

Series

Series Name: Urban Forest Sample

Data collected permanent?

Sampling: Inventory - 100% census Sampling with field plots

Sample Method: Randomized Grid

Year and Other

Year: 2009

Data units: English Metric (cm, m, hectares etc)

None
Simple Random Sample
Stratified Random Sample
Fixed Grid
Randomized Grid

Delete from Database Add to Database

Plot Info

Plot Info Define Plots

Data Collection

Sampled Paper Collection: Print Inventory Paper Collection: Print PDA Collection: Launch PDA Program Generator

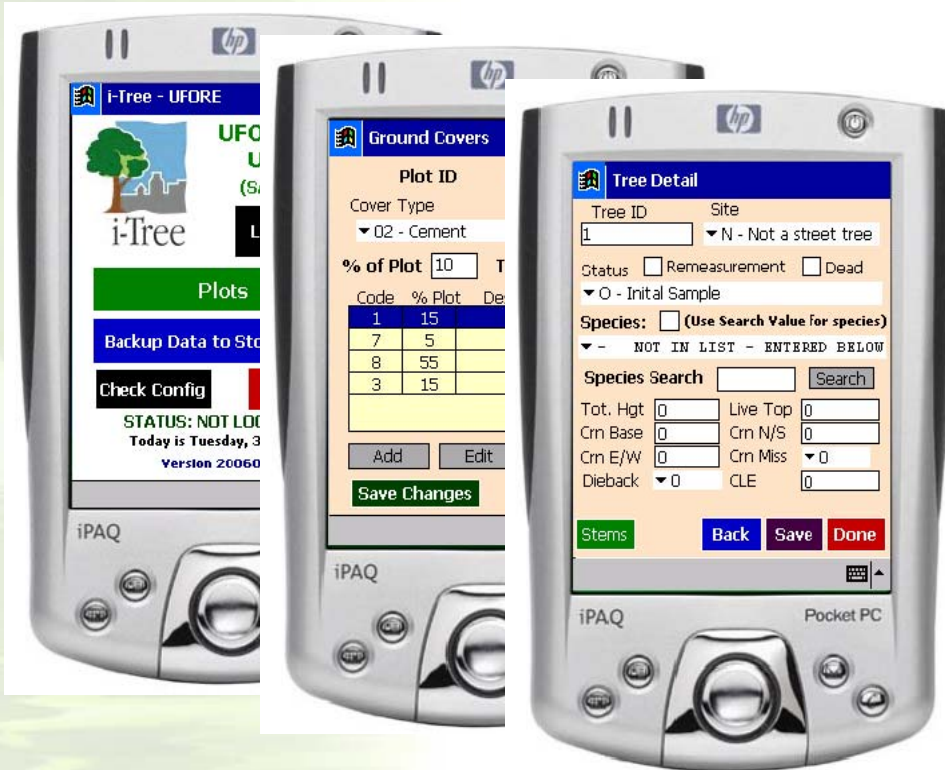
Exit

Using i-Tree Eco



i-Tree

Step 5 – Train Crews / Collect Field Data / QA-QC



Using i-Tree Eco



Step 6 – Enter Data and Analyze

Paper Data Entry for Sampled Plots

PlotID	PlotAddress	XCoordinate	YCoordinate	Date	Crew	Comment
10		1622181.42	1916249.19			
31		1621800.24	1916683.97			
32		1622197.07	1916545.98			
52		1621592.86	1917837.02			
53		1622251.54	1918012.74			
73		1621856.59	1918096.52			
74		1622558.28	1918798.13			

General Plot Info				Shrub Info			Tree Info									
Tree ID	NR	DR	DS	TreeSpecies	Land Use	HT DBH	DBH						Height			
							DBH1	DBH2	DBH3	DBH4	DBH5	DBH6	TOTHT	LiveTopCr		
1	0	-1	-1	Morus alba	Park	-1	59						10	10.07		
2	0	-1	-1	Morus alba	Park	-1	11.8	15.3	9.3				8	8		
3	0	-1	-1	Viburnum	Park	-1	4.3	6.9	4.1	3	2.9	1.9	3.4	3.48		
4	0	-1	-1	Morus alba	Park	-1	59						10	10.1		
5	0	-1	-1	Morus alba	Park	-1	11.8	15.3	9.3				8	8		
6	0	-1	-1	Morus alba	Park	-1	12.5	18.9	14.8	9.8	11.6	8.1	12	12.5		
7	0	-1	-1	Morus alba	Park	-1	11.1	13.9	12.3	7.2			10	10.4		
8	0	-1	-1	Viburnum	Park	-1	4						3.7	3.71		
9	0	-1	-1	Morus alba	Park	-1	9.3	9.8	9.1				5.7	5.7		
10	0	-1	-1	Acer negundo	Park	-1	24.8						10	10.28		
11	0	-1	-1	Morus alba	Park	-1	59						10	10.07		
12	0	-1	-1	Morus alba	Park	-1	11.8	15.3	9.3				8	8		

Contact Information

Name:

Address:

Phone: () - ext. Phone and Email are critical for returning results. Please make sure they are correct.

Email: This information will be kept confidential

Notes:



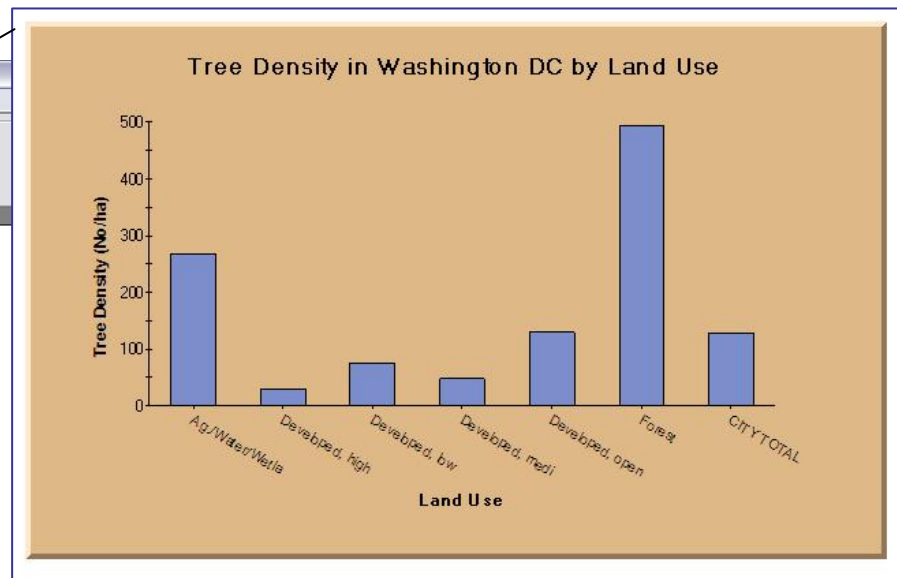
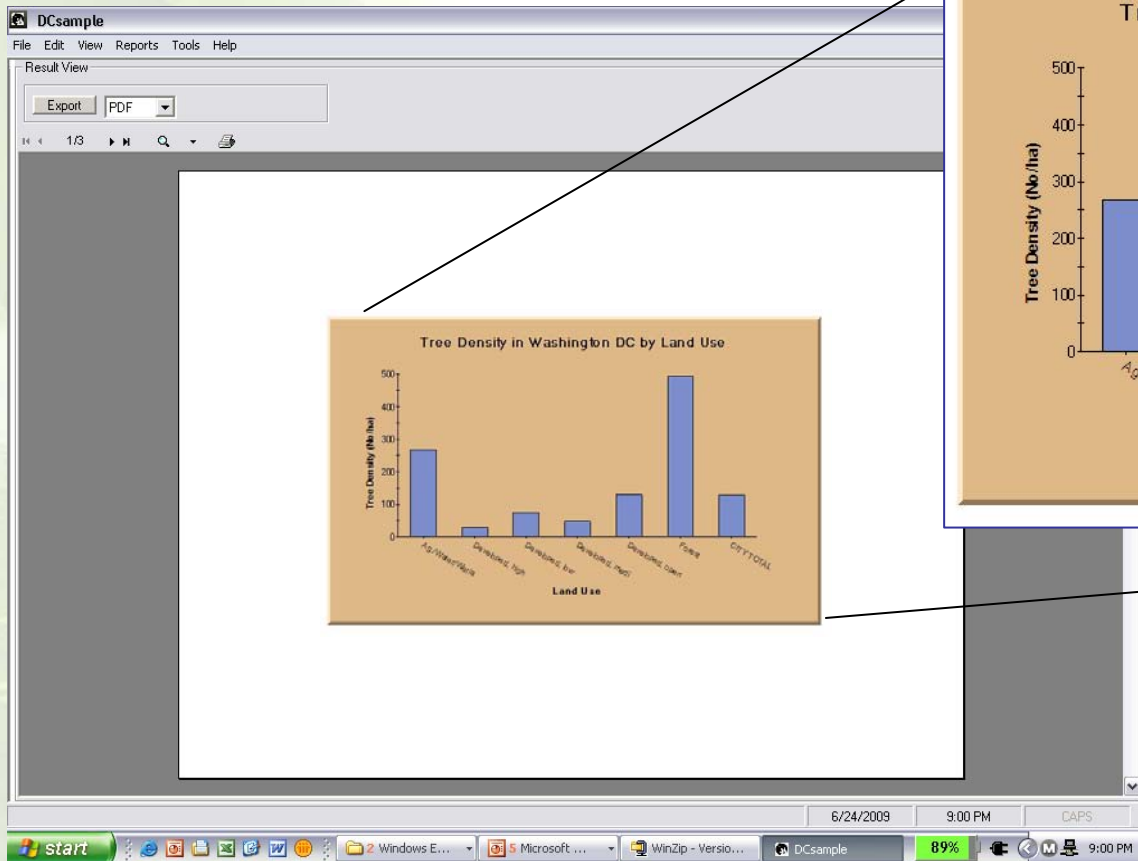
i-Tree Eco Analysis

Percent of Tree Species Population in Washington DC by DBH Class and Land Use

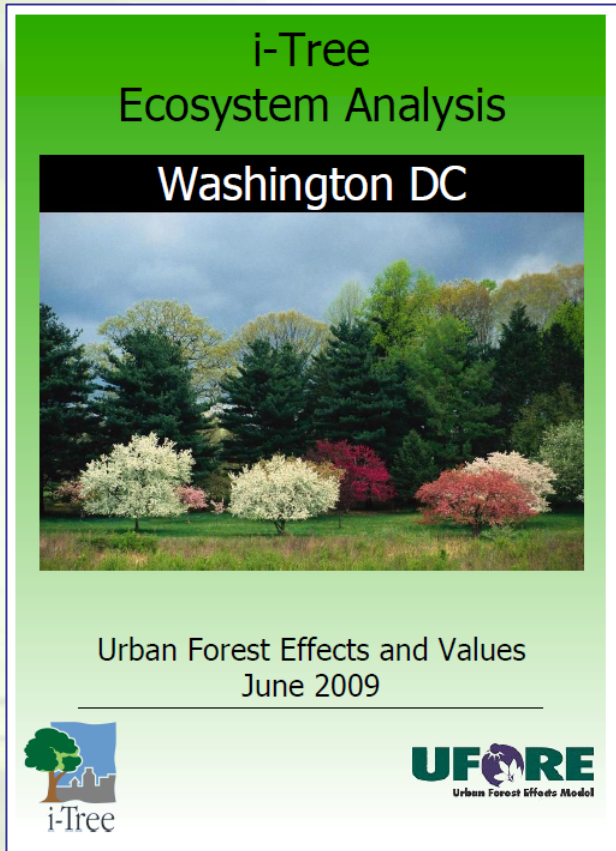
Series: Sample, Time Period: 2004

Land Use	Species	DBH		0.0 - 7.6		7.7 - 15.2		15.3 - 22.9		23.0 - 30.5		30.6 - 38.1		38.2 - 45.7		45.8 - 53.3		53.4 - 61.0		
		%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE			
Ag/Water/Wetla	American beech	50.00	0.00	15.80	0.00	15.80	0.00	6.30	0.00	6.30	0.00									
	Red maple			100.00	0.00															
	Bowlder	50.00	3.15	29.20	1.84	12.50	0.79	4.20	6.04	4.20	0.26									
	Flowering dogwood	51.80	9.76	15.20	9.76															
	Black tupelo	50.00	0.00			50.00	0.00													
	White mulberry					55.60	0.00			11.10	0.00								33.30	0.00
	White ash	33.30	33.39											33.30	16.79					
	Tree of heaven					100.00	0.00													
	Hickory			100.00	0.00															
	Other species	100.00	0.00																	
	Green ash							100.00	0.00											
	Ash														100.00	0.00				
	Sealobush	100.00	0.00																	
	Littleleaf linden	100.00	0.00																	
Nitobum	50.00	0.00	50.00	0.00																
Common persimmon									100.00	0.00										
Pin cherry	100.00	0.00																		
Total	42.50	6.50	17.20	4.50	14.90	4.54	3.40	1.55	4.60	1.35	1.10	1.21	1.10	0.95	3.40	3.62				
Developed, high	Red maple			50.00	35.97	50.00	35.97													
	Flowering dogwood	100.00	0.00																	
	Black cherry					100.00	0.00													
	Northern red oak												100.00	0.00						
	Elm	50.00	0.00	50.00	0.00															
	Common crapemyrtle	100.00	0.00																	
	Norway maple			100.00	0.00															
	Tree of heaven	25.60	12.80	25.60	10.17	14.30	5.09	14.30	5.09	14.30	16.35									
	Crapepple	33.30	0.00			66.70	0.00													
	American holly	20.00	0.00	50.00	0.00															
	Sugar maple									100.00	0.00									
	Eastern red cedar					100.00	0.00													
	Pin oak																		100.00	0.00
	Southern magnolia			100.00	0.00															
	Dogwood	100.00	0.00																	
	Japanese maple									100.00	0.00									
	Kousa dogwood			100.00	0.00															
	Nectarine	100.00	0.00																	
	Total	34.30	7.97	31.40	8.99	17.10	7.63	2.90	2.57	8.60	4.16	2.90	2.92					2.90	3.00	
	Developed, low	Red maple			100.00	0.00														
Tulip tree				20.00	5.55	10.00	4.29	10.00	10.01	20.00	8.58	20.00	20.03					20.00	5.55	
Flowering dogwood		66.70	14.02	33.30	14.02															
Black cherry		60.00	17.17								20.00	22.89	20.00	5.72						
Northern red oak											16.70	10.51			33.30	7.95	33.30	7.95		
Elm			100.00	0.00																

i-Tree Eco Analysis



Automatic Report Generator



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).

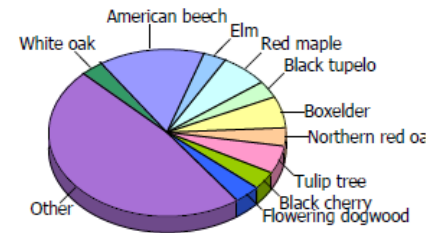


Figure 1. Tree species composition in Washington DC

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

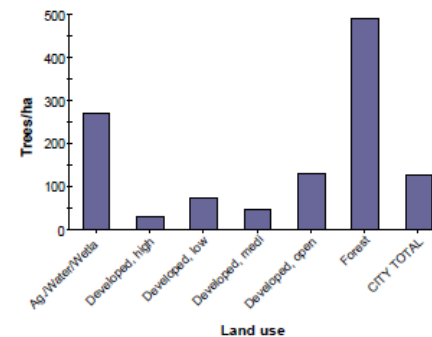


Figure 2. Number of trees/ha in Washington DC by land use

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i-Tree Eco User's Manual

Demo i-Tree Eco



Wrap-Up



- Questions
- Discussion
- Other Points