Inventory and Assessment

Using i-Tree to Examine Changes in a Community's Urban Forest

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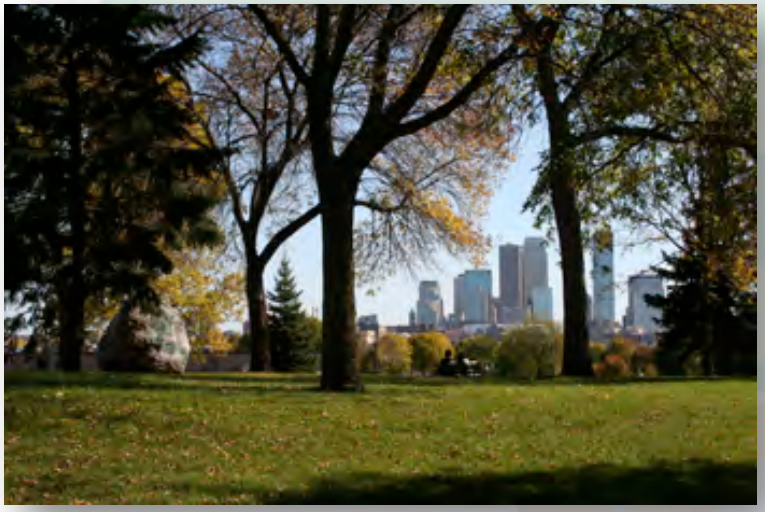
Today's Session



- Urban Forests in Context
- What is i-Tree: An Overview
- i-Tree Components & Tools
- Urban Tree Canopy Reports
- Examining Historical Data
- Telling Your Story

Urban Forests & Tree Canopy

Urban Forests & Tree Canopy

Brooklyn, NY

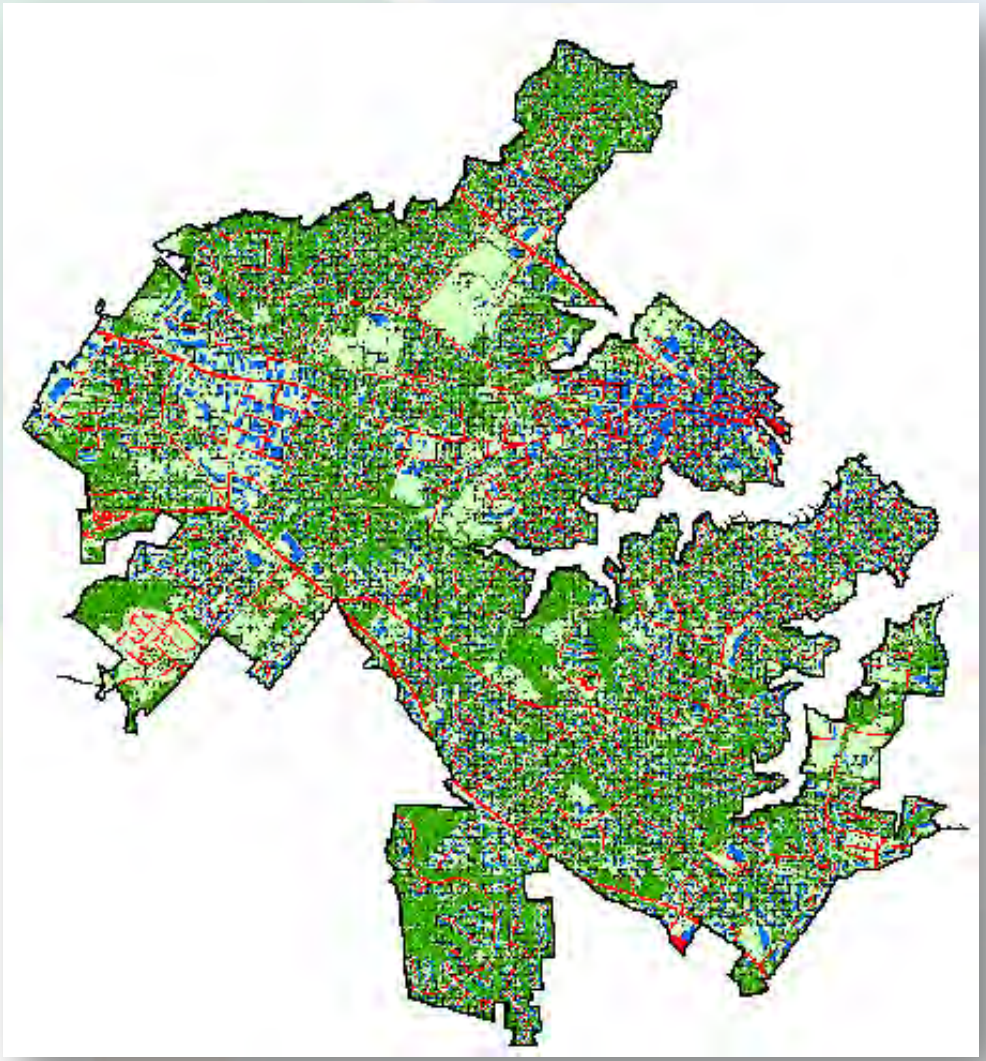
Urban Forests & Tree Canopy

Chicago, IL

Urban Forests & Tree Canopy

Detroit, MI

Urban Forests & Tree Canopy



Annapolis, MD

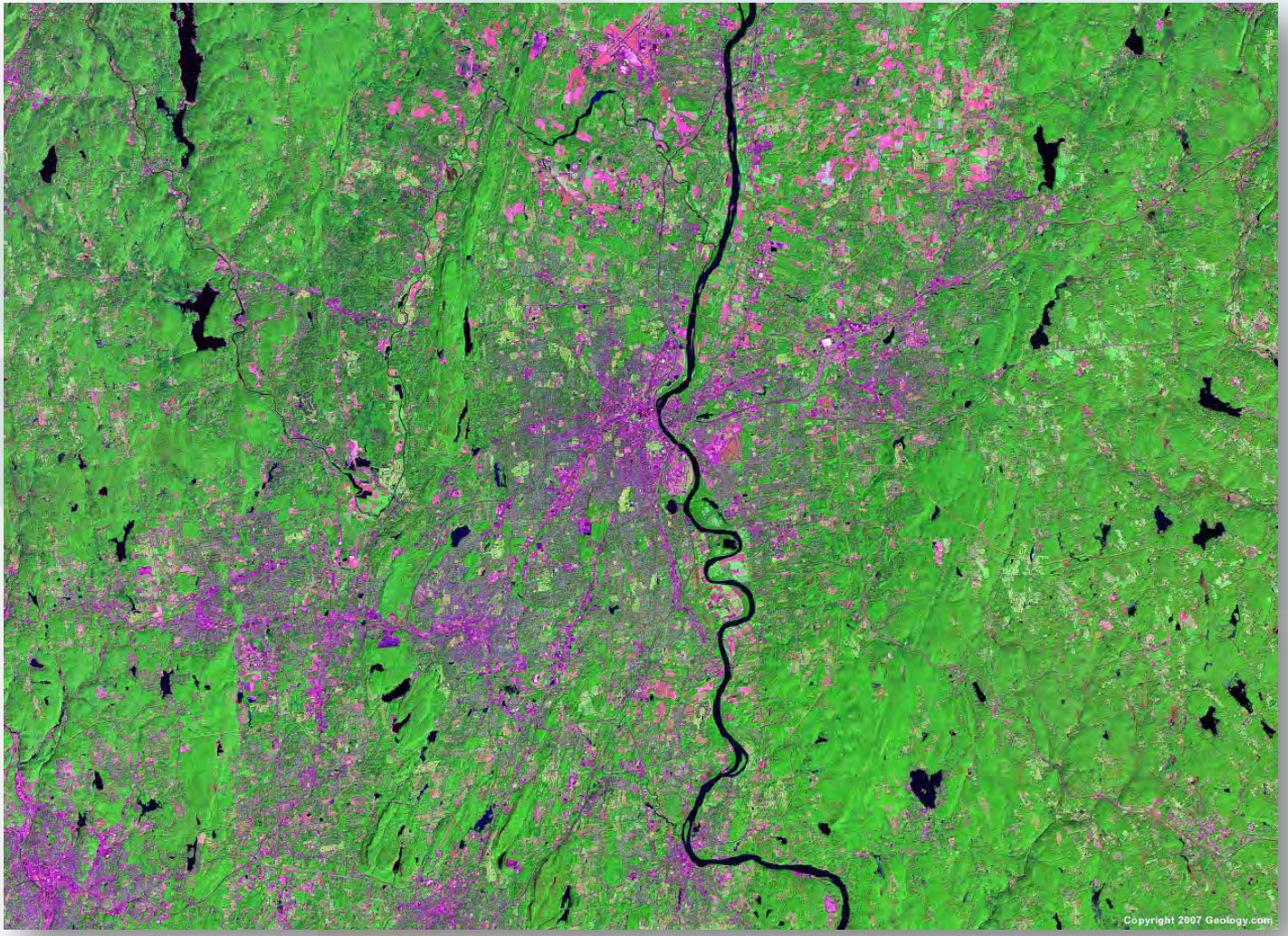
Urban Forests & Tree Canopy

Long Island, NY

Urban Forests & Tree Canopy

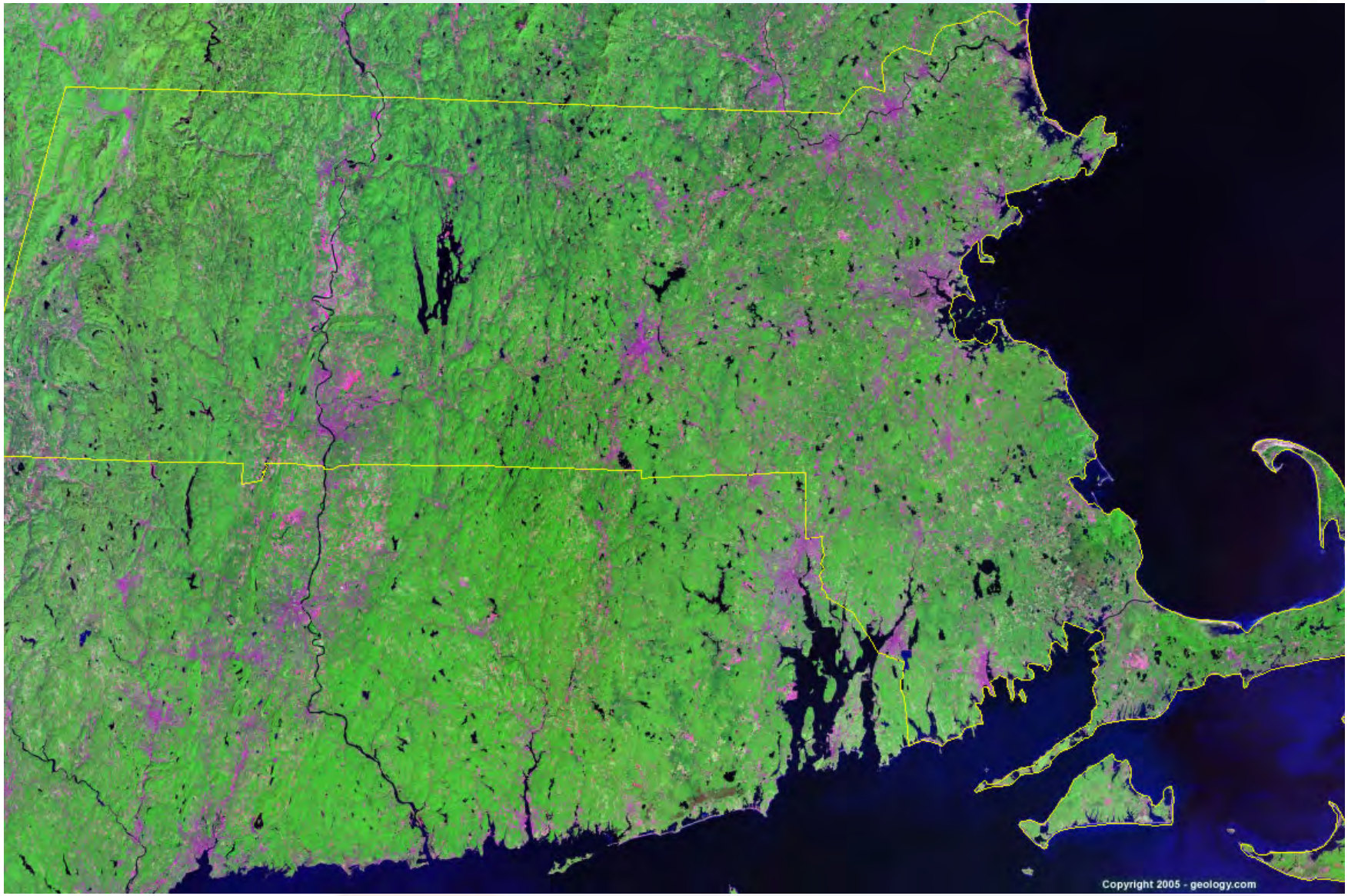
New York City

Urban Forests & Tree Canopy

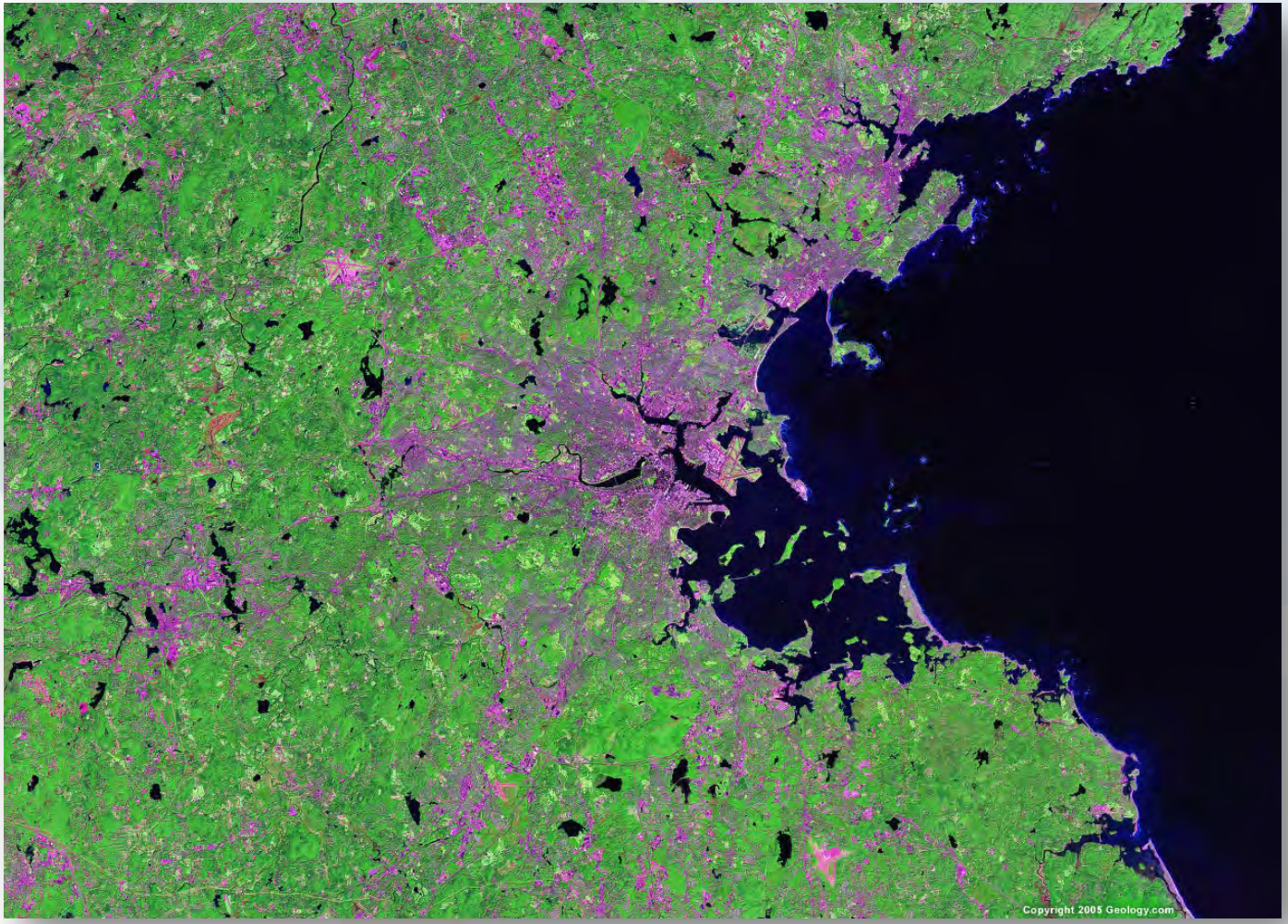


Hartford, CT

Urban Forests & Tree Canopy

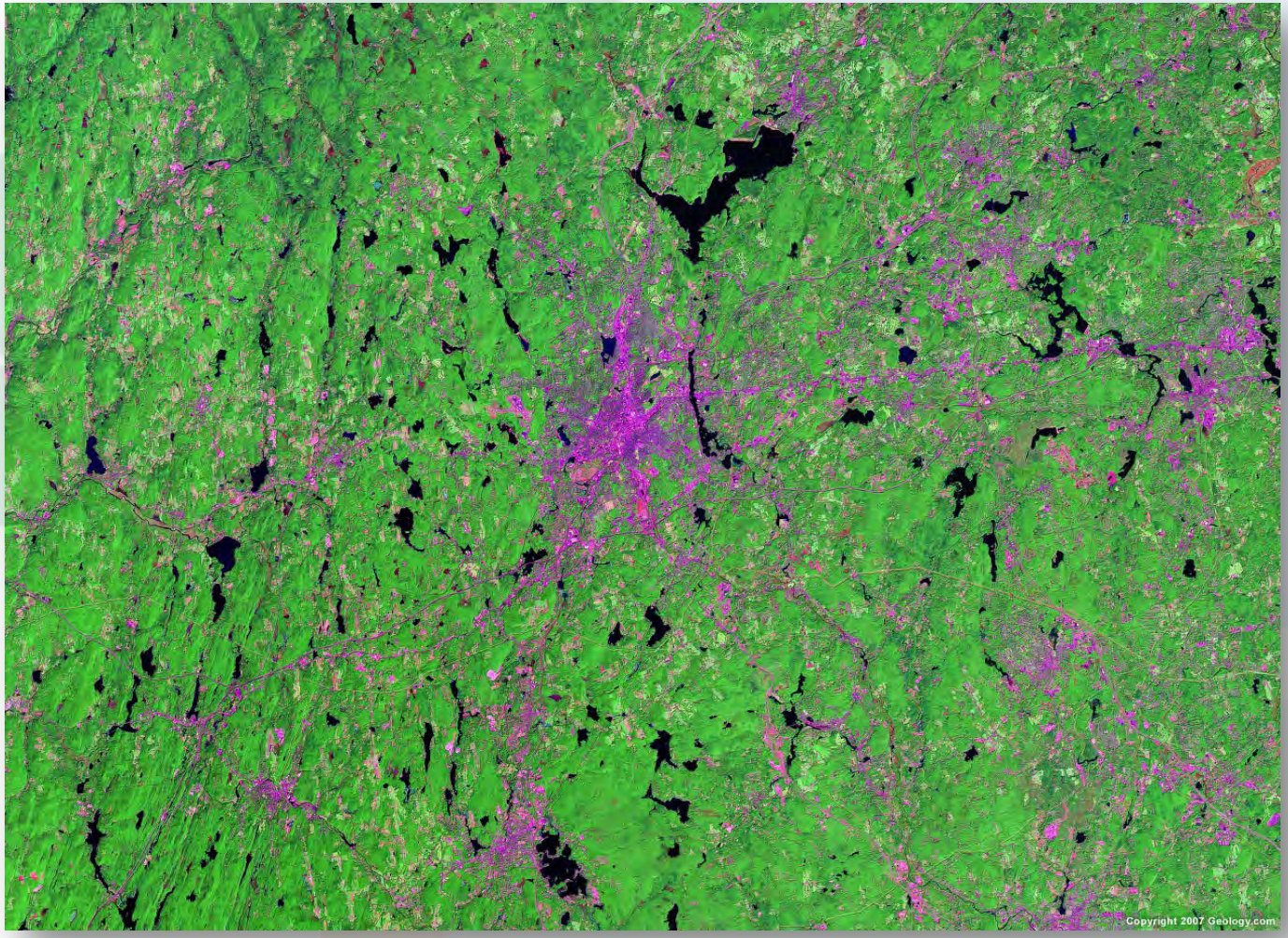


Urban Forests & Tree Canopy



Boston, MA

Urban Forests & Tree Canopy



Worcester, MA

Urban Forests & Tree Canopy

Urban Forests & Tree Canopy

Urban Forests & Tree Canopy

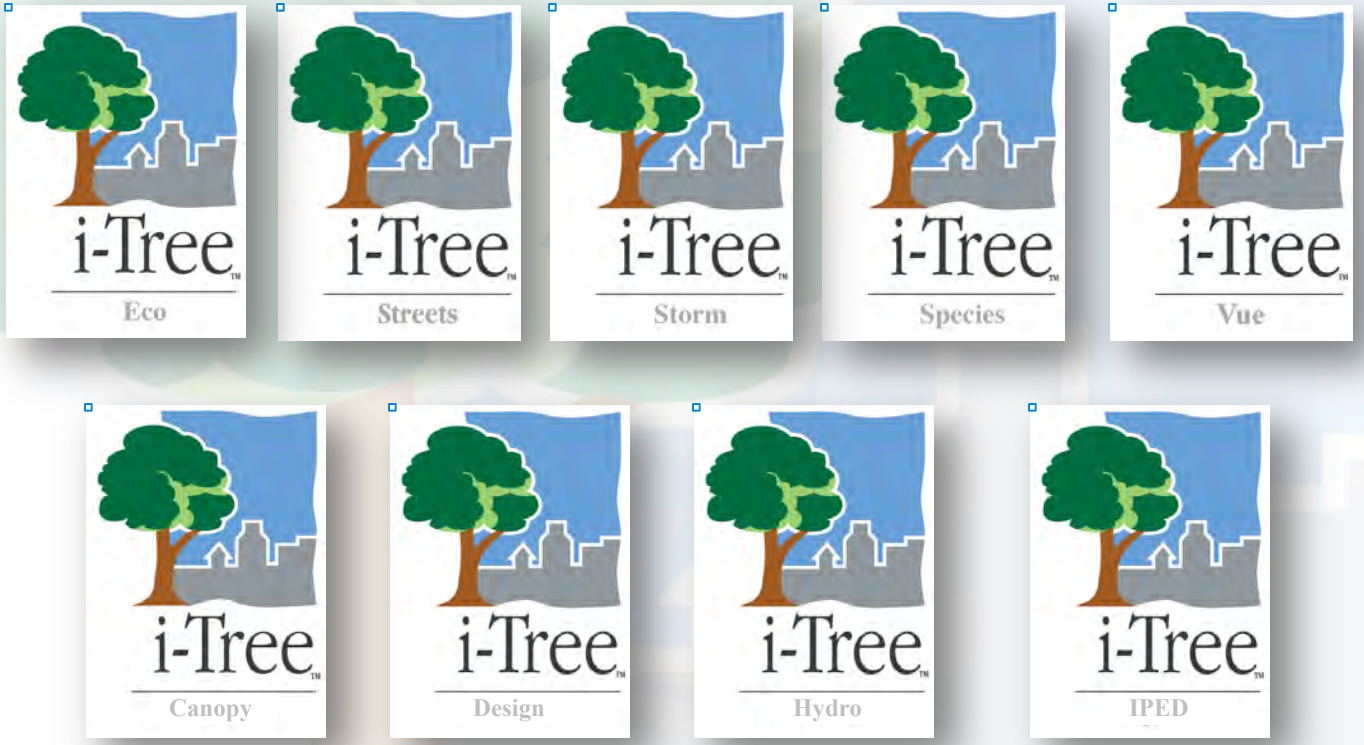
What is i-Tree?

Inventory of Tree Resources: Economic and Environmental

i-Tree: Urban Forest Inventory Analysis Tool

What is i-Tree?

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



What is i-Tree?

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

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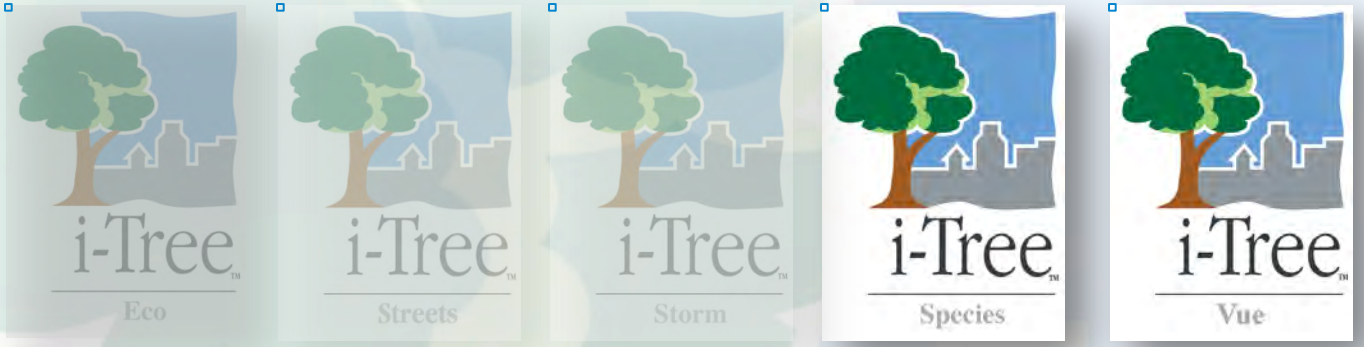
A suite of software tools to assess urban vegetation and their ecosystem services and values



Canopy Design Hydro IPED

What is i-Tree?

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

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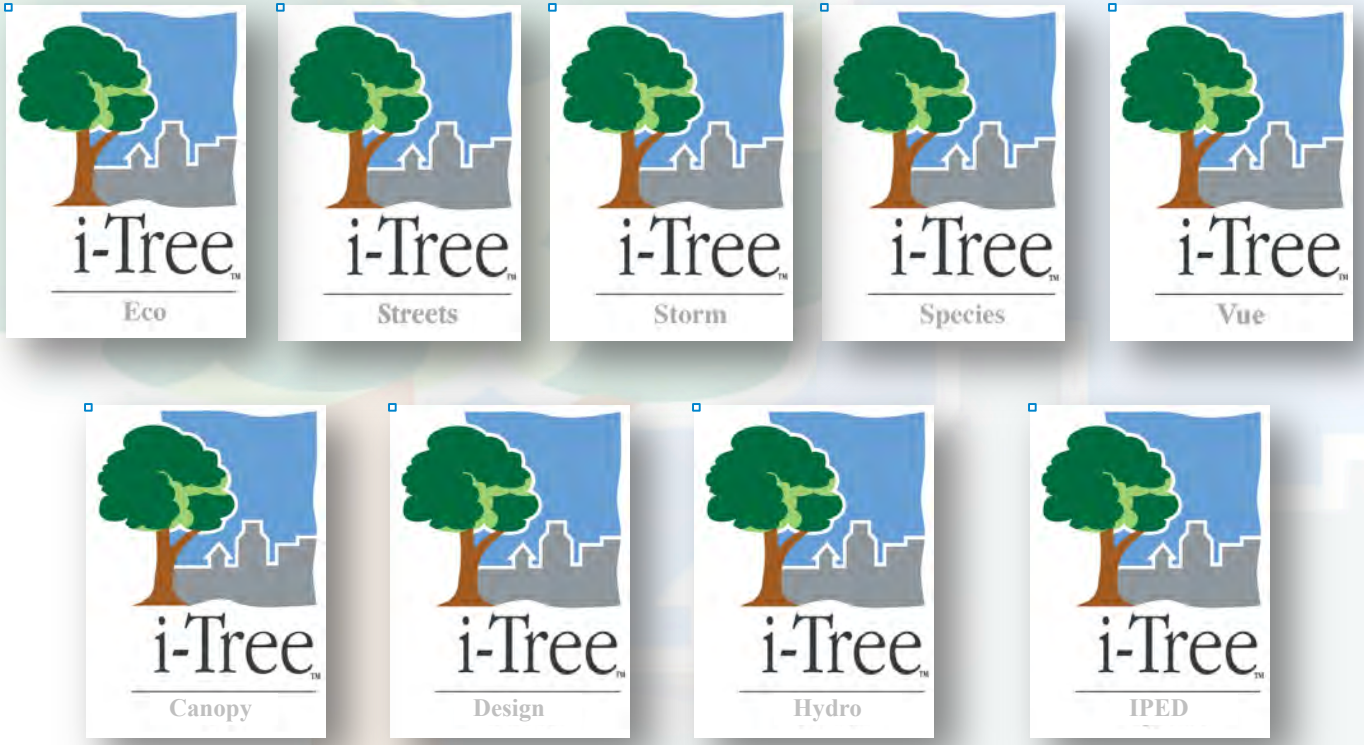


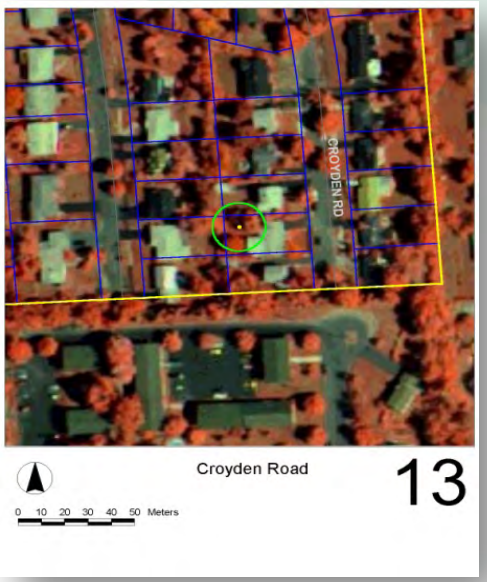
Public-Private Partnership

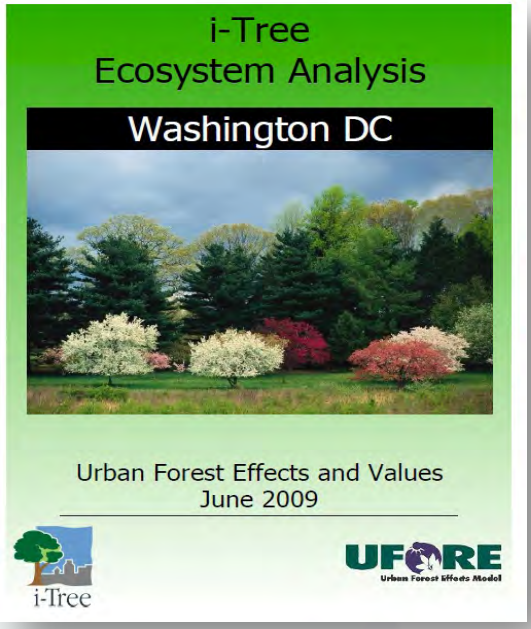
- USDA Forest Service
- Davey Tree Expert Co.
- National Arbor Day Foundation
- Society of Municipal Arborists
- International Society of Arboriculture
- Casey Trees

Goals

- Simple and low-cost tools and methods to aid in urban forest planning and management

- Complete process – start to finish

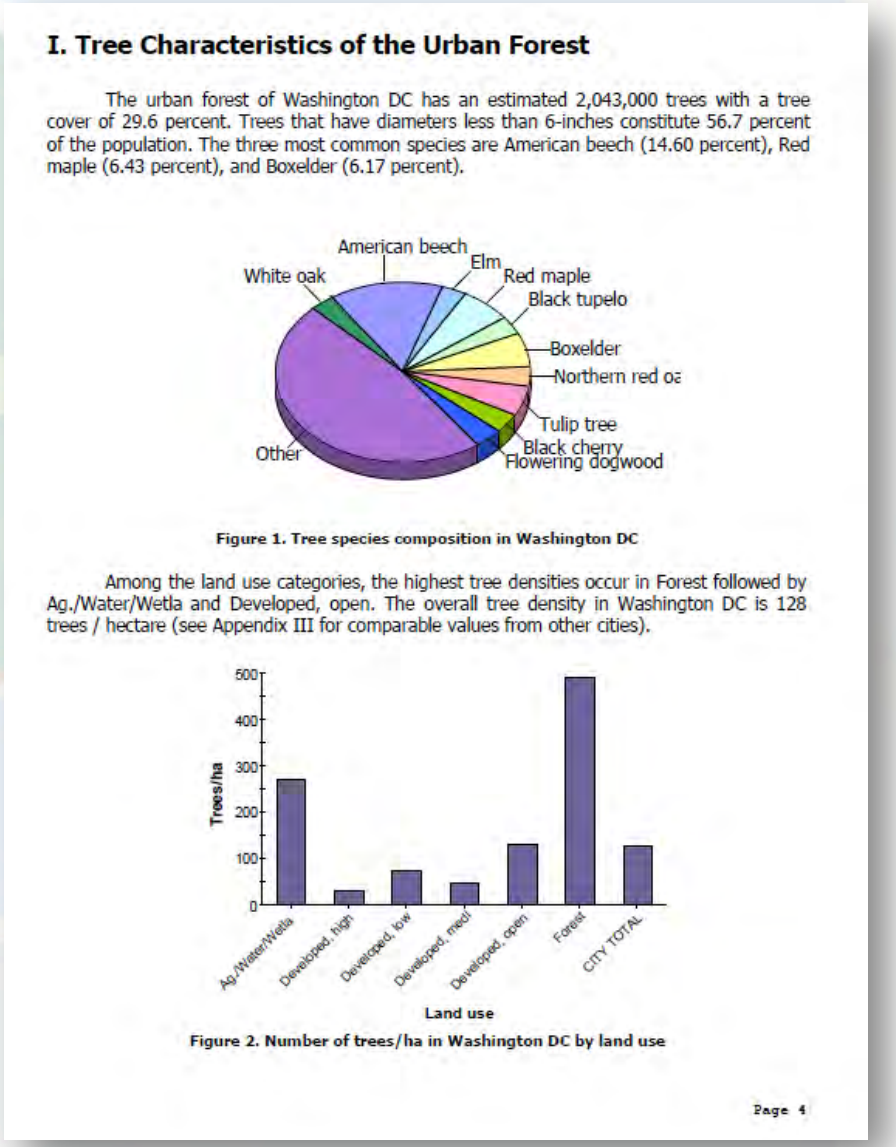




Assessing Tree Populations

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/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

Benefit-Based Approach

i-Tree

i-Tree Tools

The Foundation: Local Data

Local Sample or Inventory

Local information:

- Weather
- Pollution
- Environmental Variables

Hourly simulations

Conserving Energy

Image courtesy of the Center for Urban Forest Research

Improving Air Quality

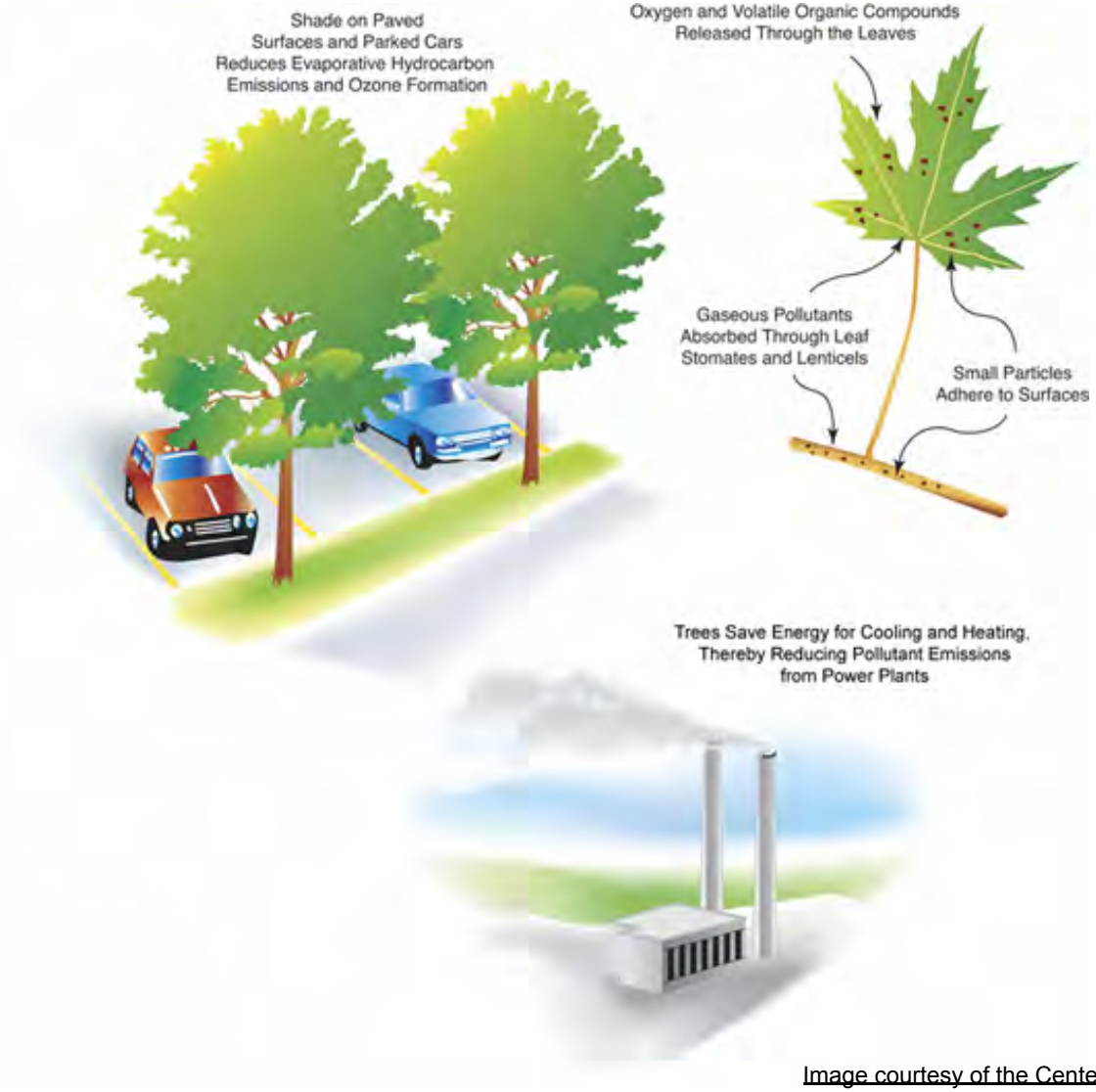


Image courtesy of the Center for Urban Forest Research

Reducing Atmospheric Carbon Dioxide

Image courtesy of the Center for Urban Forest Research

Reducing Stormwater Runoff

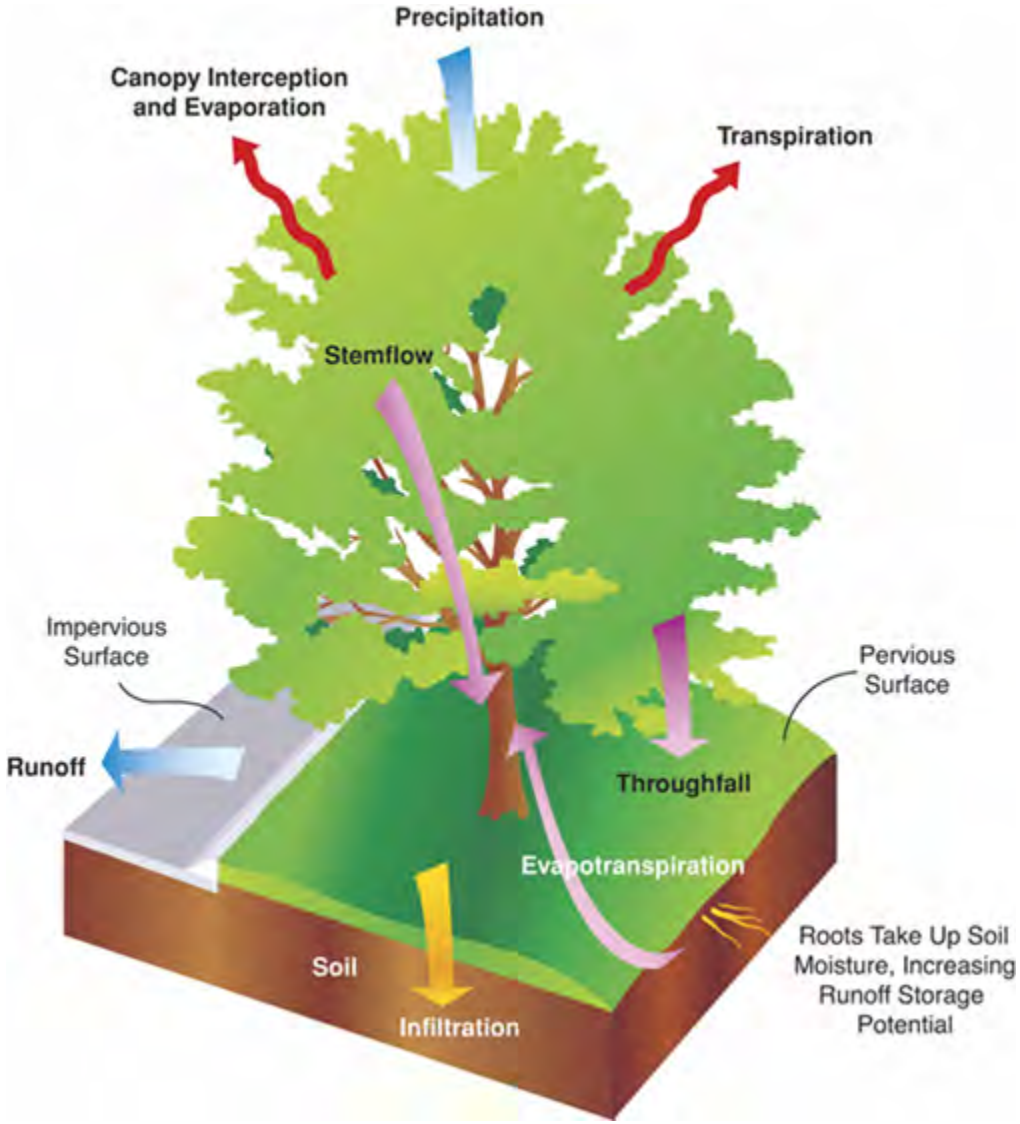


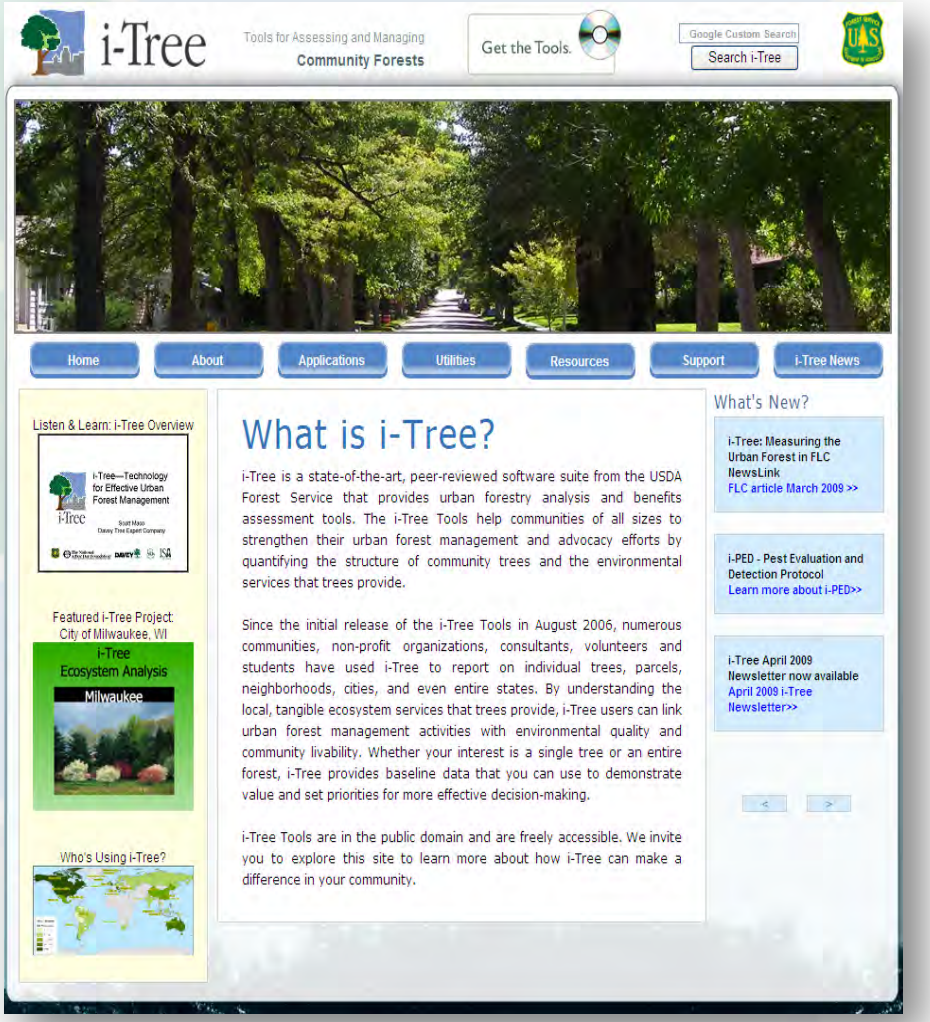
Image courtesy of the Center for Urban Forest Research

i-Tree is…

Development, Dissemination, Support, & Refinement

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

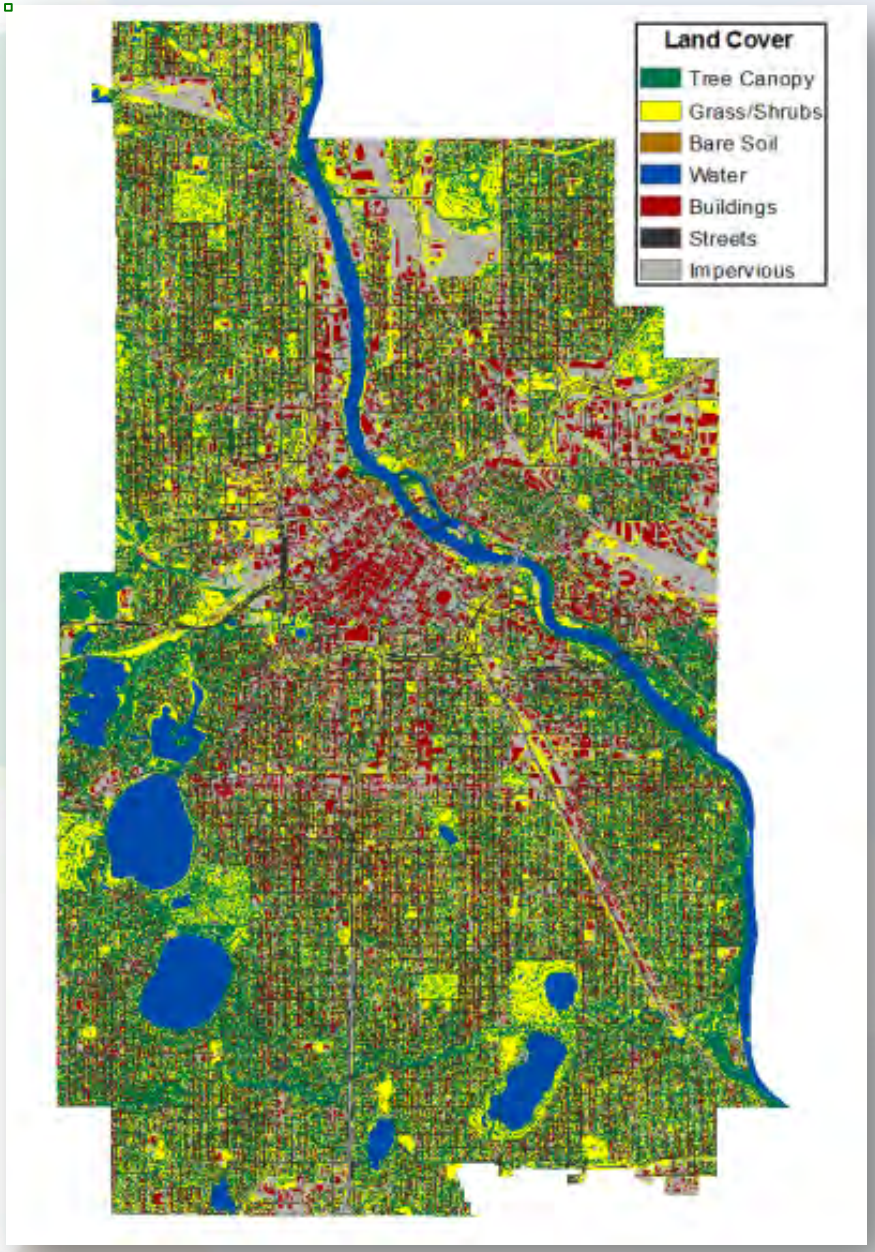
"Putting USFS Urban Forest science into the hands of users"

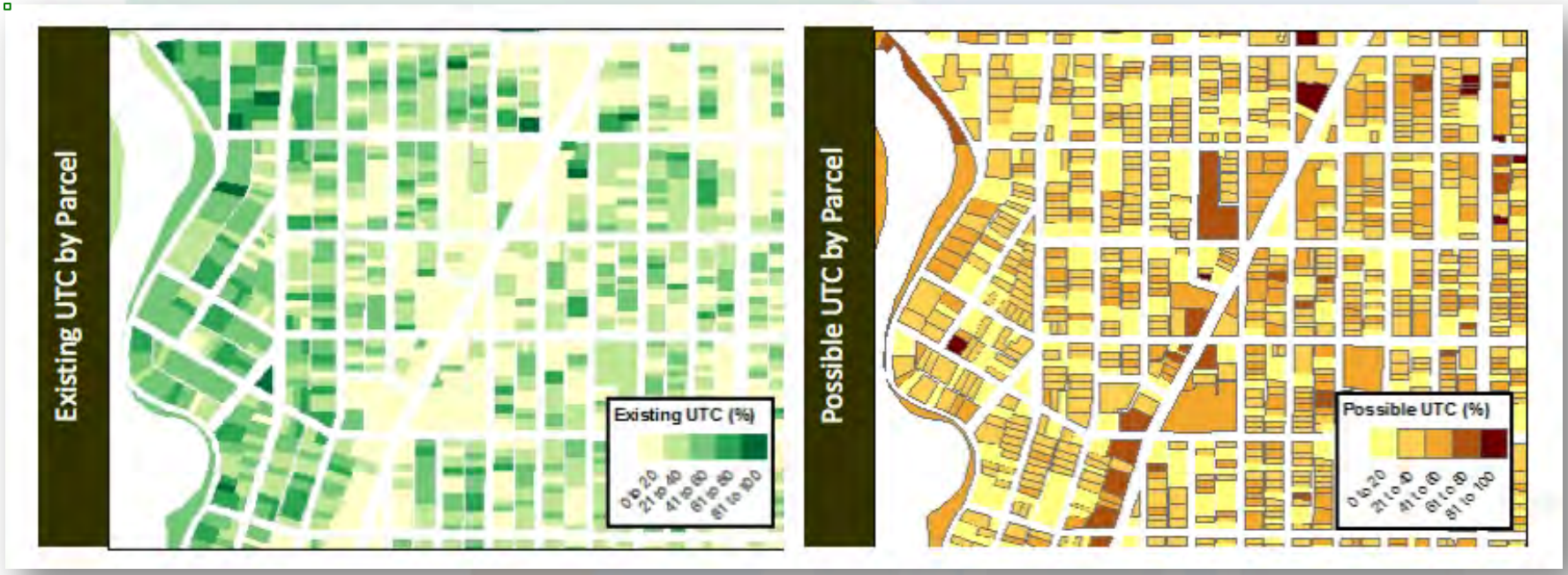


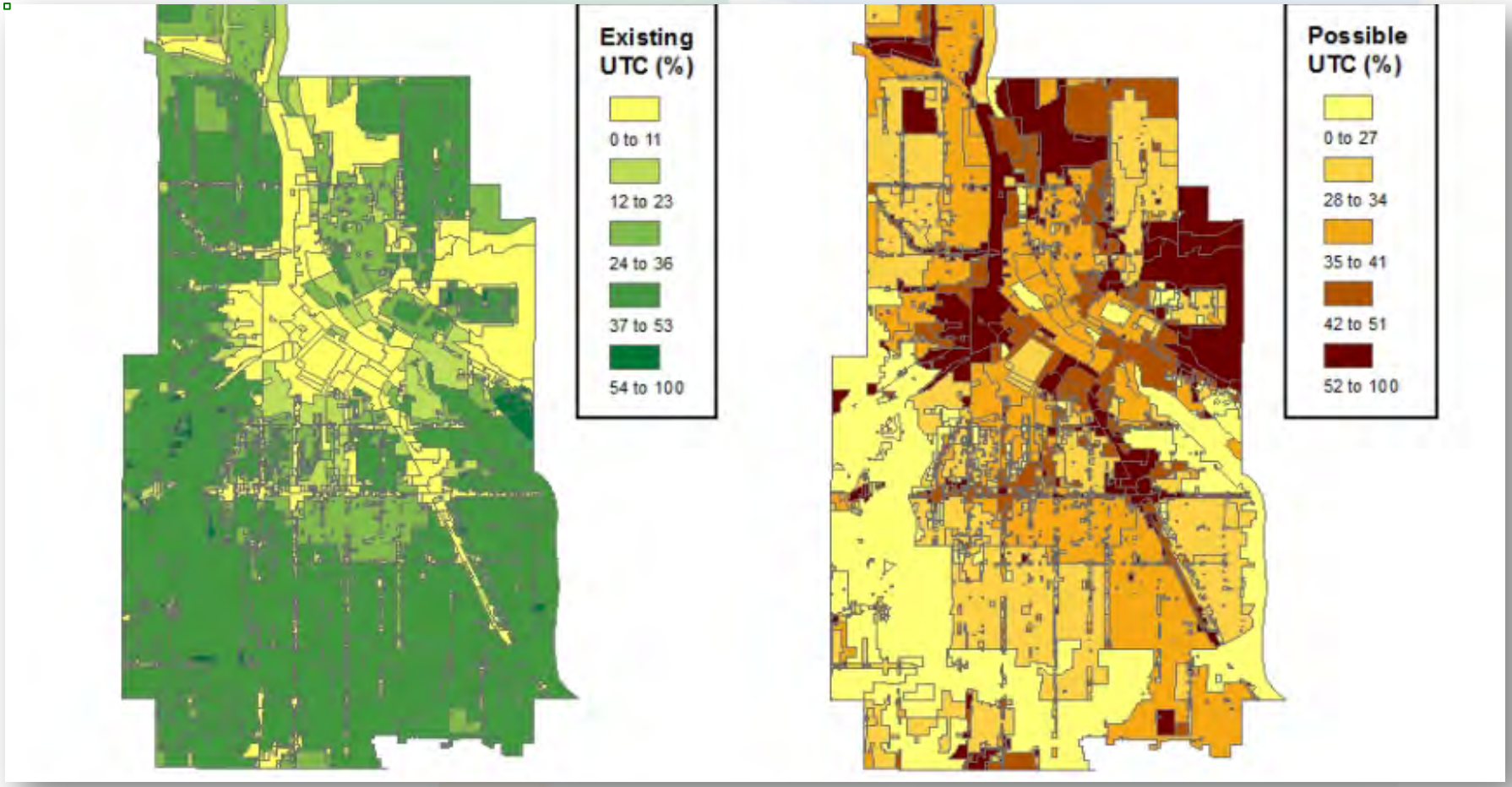
Urban Tree Canopy (UTC)

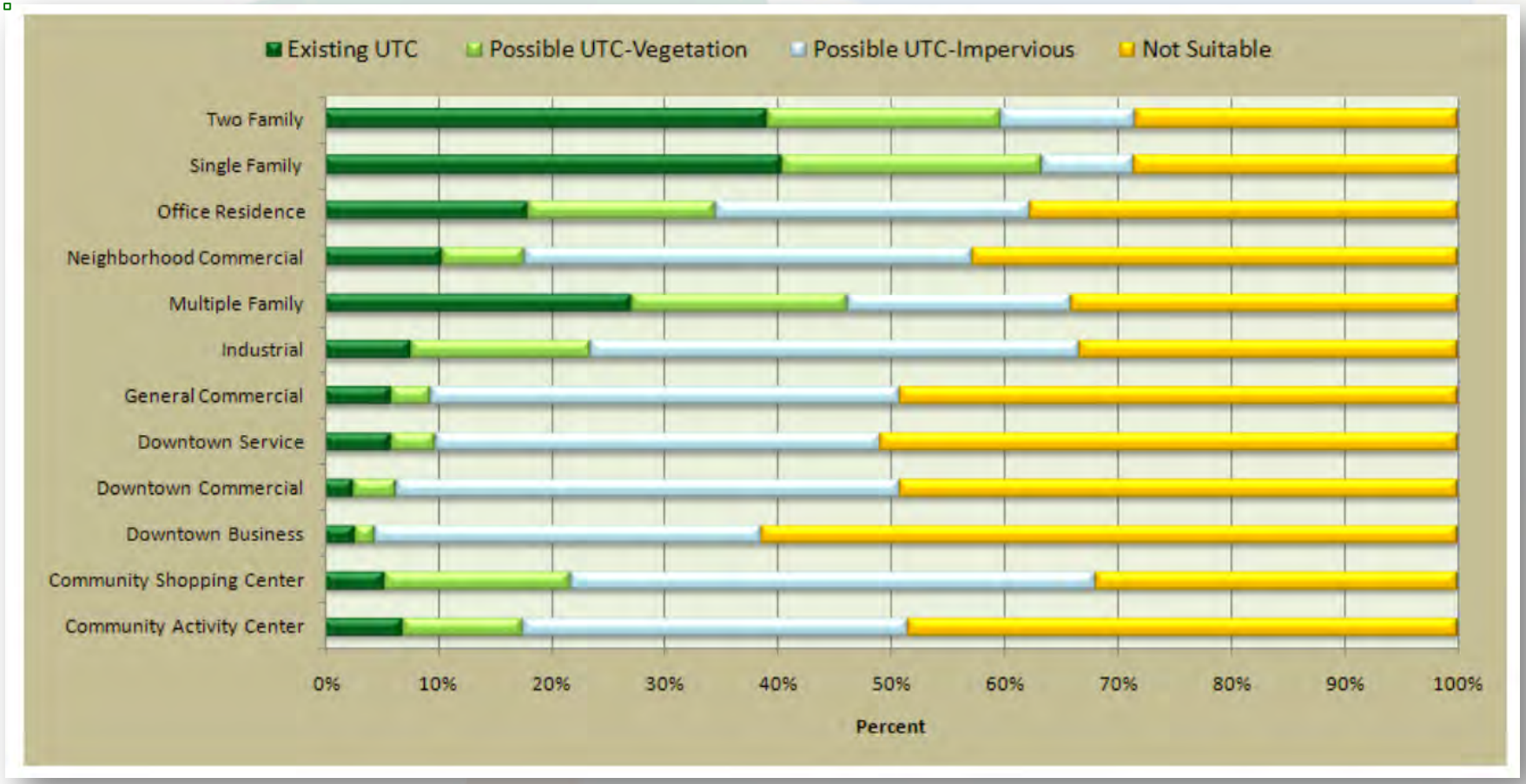
Assessment and Analysis

Minneapolis, MN


Land Cover
Tree Canopy
Grass/Shrubs
Bare Soil
Water
Buildings
Streets
Impervious


Existing UTC by Parcel
Existing UTC (%)
0 to 20
21 to 40
41 to 60
61 to 80
81 to 100
Possible UTC by Parcel
Possible UTC (%)
0 to 20
21 to 40
41 to 60
61 to 80
81 to 100


Existing
UTC (%)
0 to 11
12 to 23
24 to 36
37 to 53
54 to 100
Possible
UTC (%)
0 to 27
28 to 34
35 to 41
42 to 51
52 to 100


Existing UTC
Possible UTC-Vegetation
Possible UTC-Impervious
Not Suitable
Two Family
Single Family
Office Residence
Neighborhood Commercial
Multiple Family
Industrial
General Commercial
Downtown Service
Downtown Commercial
Downtown Business
Community Shopping Center
Community Activity Center
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent

Vancouver, WA

Vancouver 2011 Urban Tree Canopy Assessment Report

Acknowledgements

Vancouver City Council

Timothy D. Leavitt, Mayor
Jeanne Harris
Jeanne E. Stewart
Larry J. Smith
Pat Campbell
Jack Burkman
Bart Hansen

Vancouver Urban Forestry Commission

James Wasden, Chair
Terry Toland, Vice-Chair
Phil Kimery
Tim Carper
Alexander Chabert
Craig Smith
Anne Friesz, Parks and Recreation Advisory Commission Liaison

City of Vancouver

Eric Holmes, City Manager
Brian Carlson, Public Works Director
Rich McConaghy, Environmental Resources Manager
Charles Ray, Urban Forester
Annette Griffy, Surface Water Engineering Manager
Dorie Sutton, Senior Engineering Technician
Eugene Durshpek, Asset Management/Engineering GIS Supervisor
Merek Strand, Senior Engineering Technician
Jessica Antoine, Urban Forestry Outreach Coordinator
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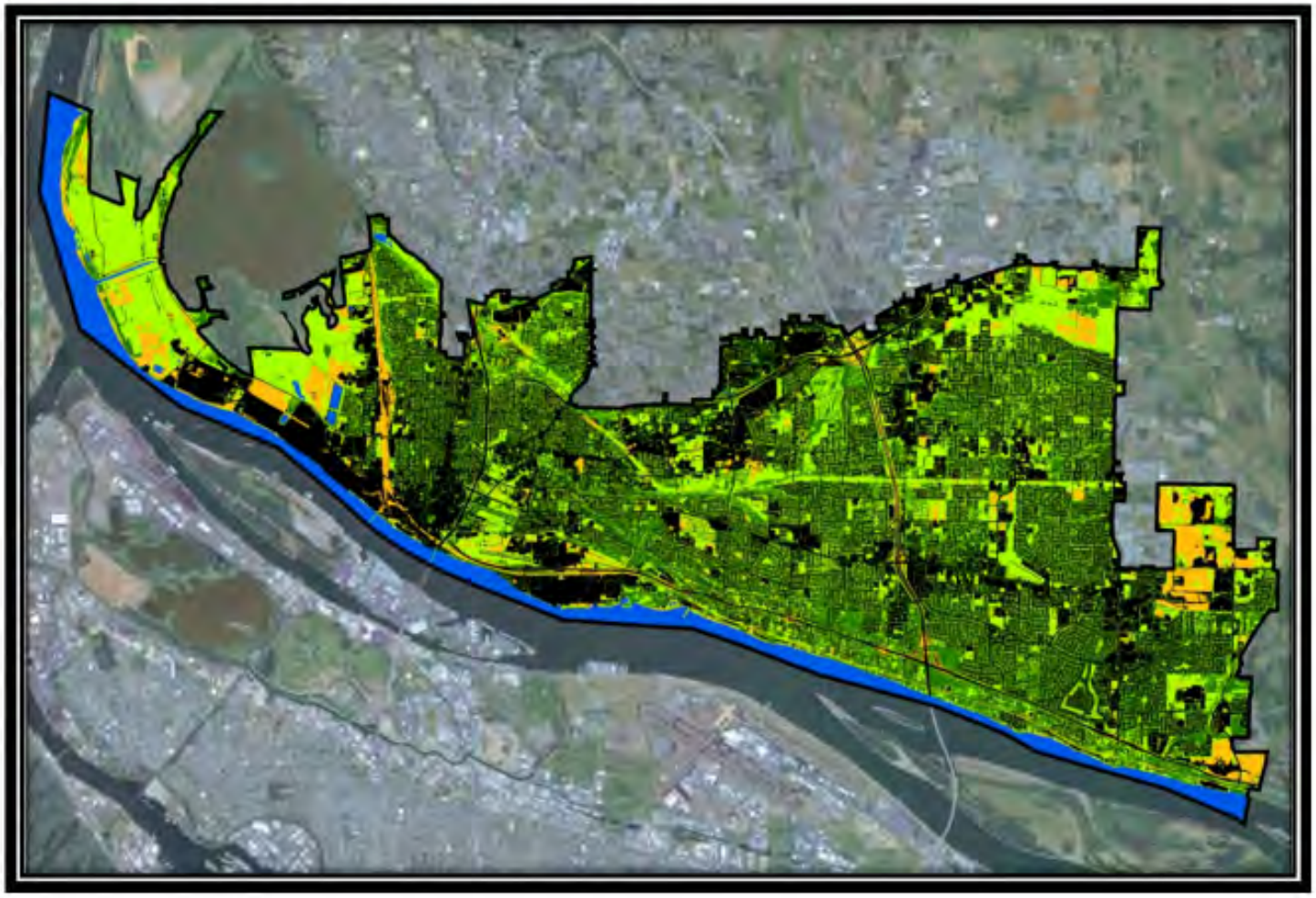
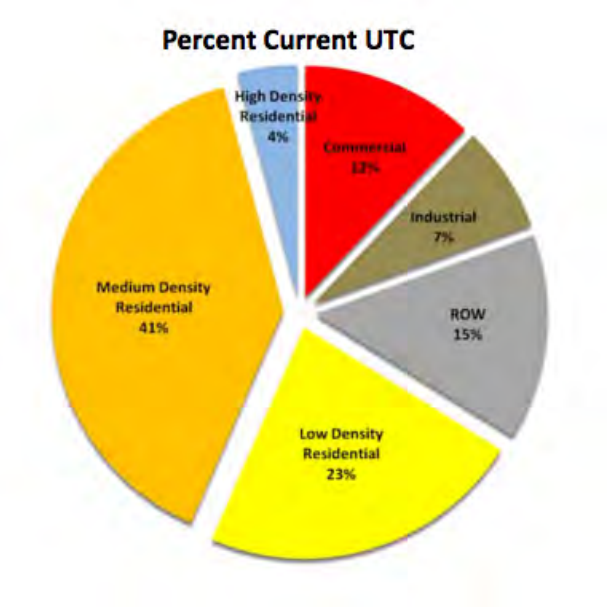
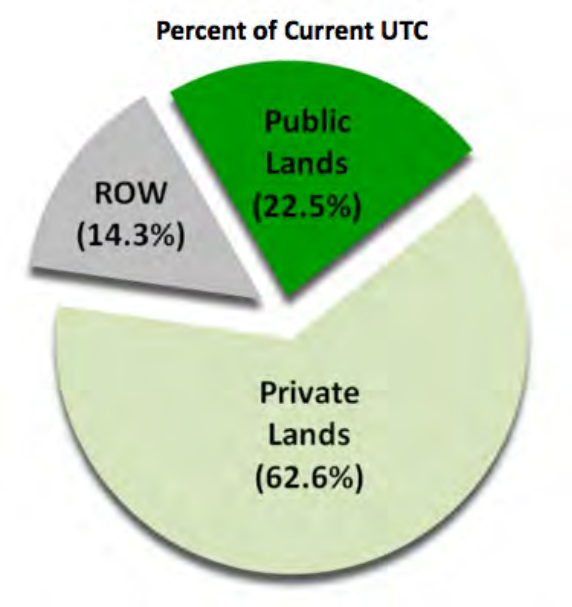
i-Tree VUE


2010 WorldView2 Satellite Imagery
color-infrared
Impervious Surface Layers
Land Cover
Impervious
Dry Vegetation/Soil
Trees/Forest
Water

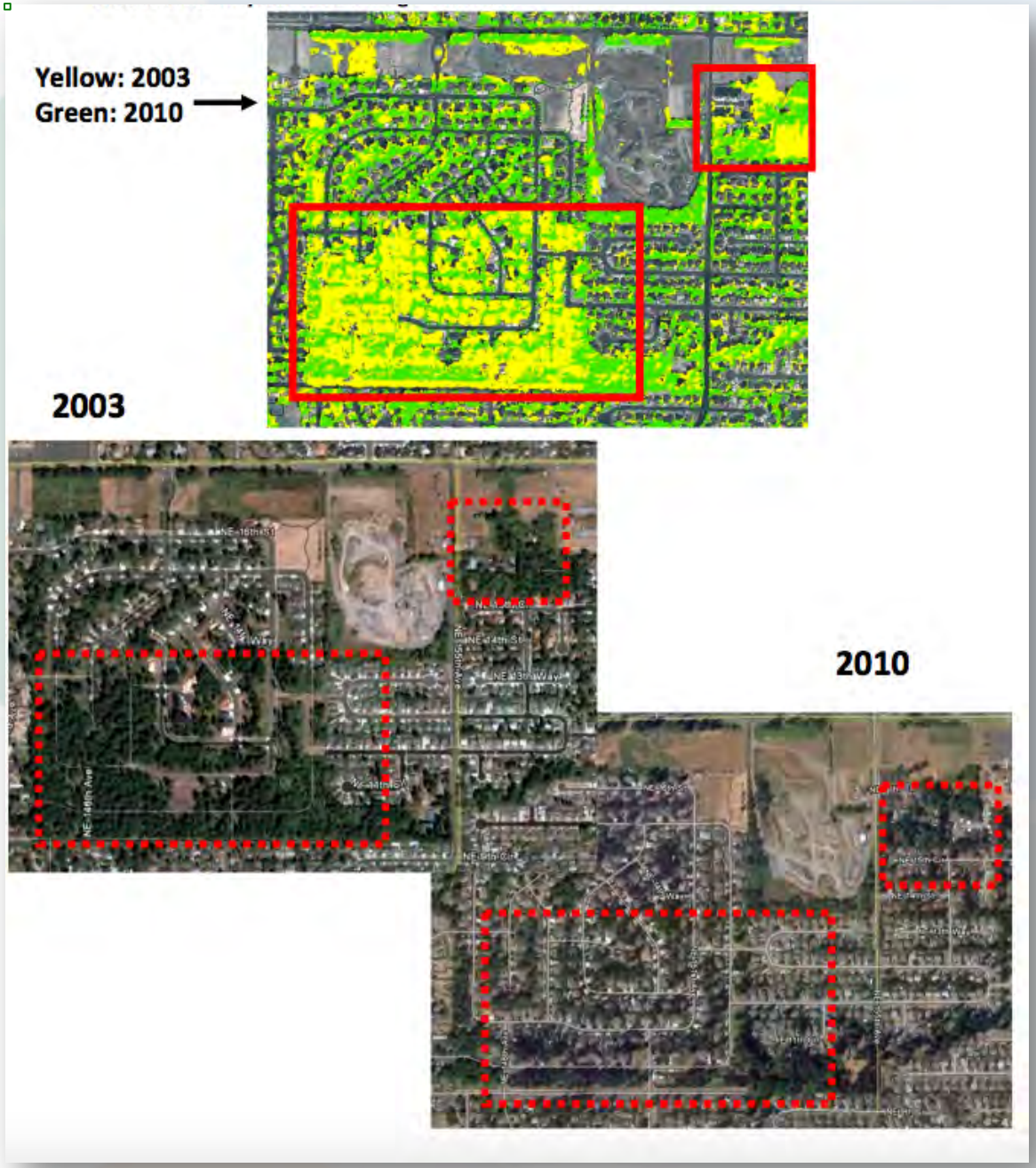
Figure 2. **Classified land cover for Vancouver.**
Dark green = Trees and Forest, Light green = other vegetation, Black = impervious surfaces, Blue = water, and Orange = soils and dry vegetation.



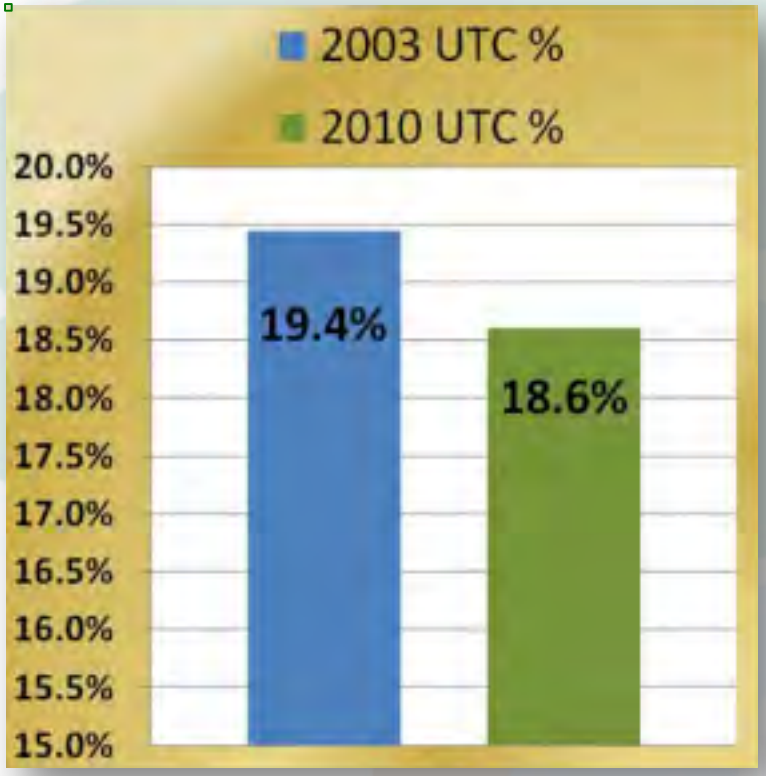




	Total Acres	Trees Acres	Trees %	Veg/ Non-Forest Acres	Veg/ Non-Forest %	Impervious Acres	Impervious %	Water Acres	Water %	Soil/Dry Veg Acres	Soil/Dry Veg %
City of Vancouver	32,436	5,579	17%	9,952	31%	12,370	38%	2,437	8%	2,097.00	6%

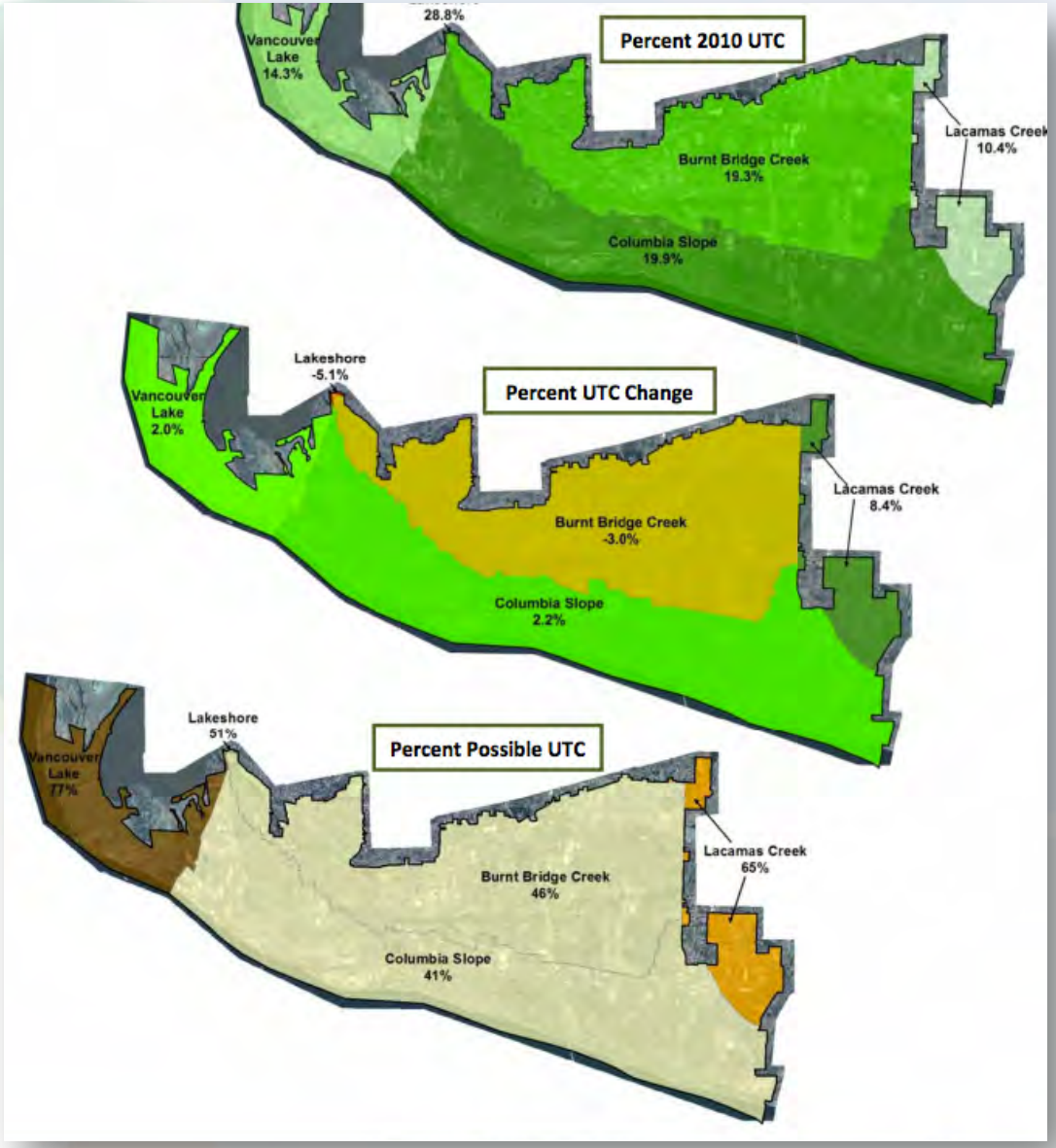

Yellow: 2003
Green: 2010
2003
2010

Urban Tree Canopy Changes



253

Acres of forest lost mainly due to development between 2003 and 2010 in Vancouver (4.3% of total 2003 tree canopy)


28.8%
Vancouver Lake 14.3%
Percent 2010 UTC
Lacamas Creek 10.4%
Burnt Bridge Creek 19.3%
Columbia Slope 19.9%
Lakeshore -5.1%
Vancouver Lake 2.0%
Percent UTC Change
Lacamas Creek 8.4%
Burnt Bridge Creek -3.0%
Columbia Slope 2.2%
Lakeshore 51%
Vancouver Lake 77%
Percent Possible UTC
Lacamas Creek 65%
Burnt Bridge Creek 46%
Columbia Slope 41%

Target Feature Class	Features	Names	Average Area (Acres)	Average 2003 Canopy %	Average 2010 Canopy %	Average Canopy % Change
Citywide	1	Vancouver City Boundary	32,436	18.0%	17.2%	-0.8%
Neighborhoods	(86)	See Table A.1	377	22.9%	21.6%	-1.2%
Watersheds	1	Vancouver Lake/Lake Riv	6,486	16.9%	17.2%	0.3%
	2	Lacamas Creek				
	3	Lakeshore				
	4	Burnt Bridge Creek				
	5	Columbia Slope				
Ownership Type	1	Public	7,599	17.5%	15.4%	-2.0%
	2	Private				
	3	Right of Way				
	4	BPA Right of Way				
Zoning Type	1	Commercial	4,341	18.0%	17.1%	-0.9%
	2	Indisutrial				
	3	Right of Way				
	4	BPA Right of Way				
	5	Single Family High Density				
	6	Single Family Low Density				
	7	Single Family Medium Density				

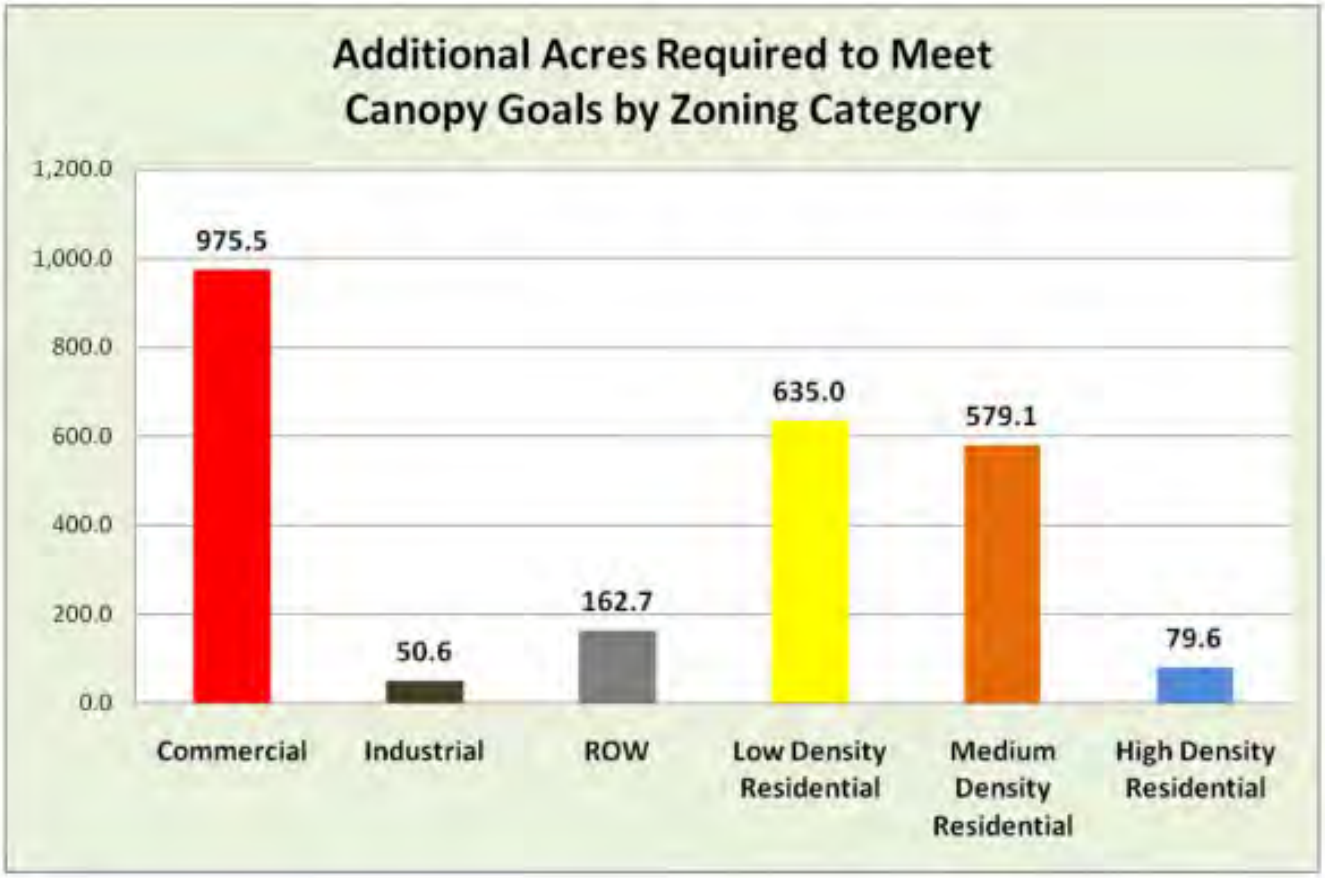
18.6

Percent of Vancouver land area covered by Tree Canopy in 2010

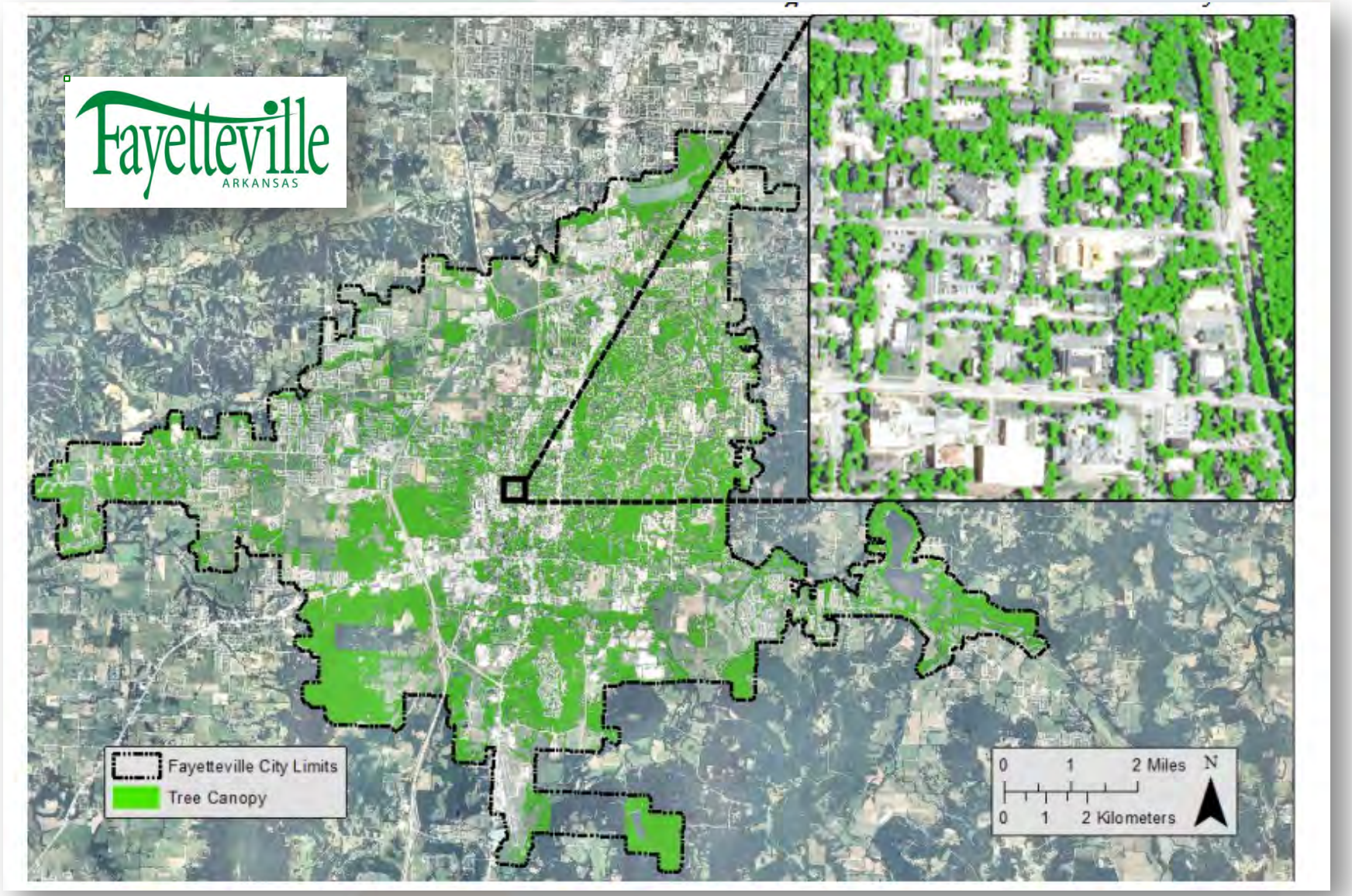
-9.4

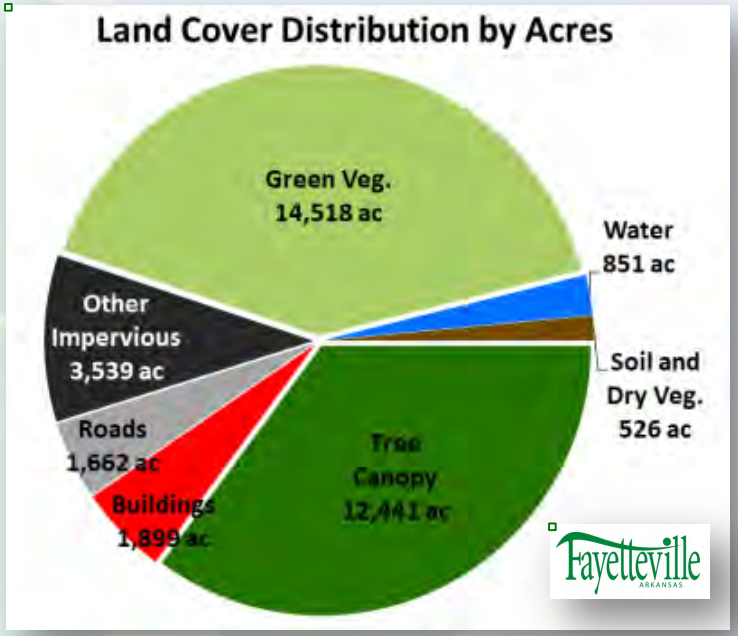
Citywide percentage below canopy goal of 28%

NAME	Total Acres Excluding Water	2003 UTC Acres	2003 UTC Percent	2010 UTC Acres	2010 UTC Percent	Change in UTC Acres	Change in UTC Percent	Total Possible Acres	Total Possible %
Vancouver Lake	2,939.3	360.8	12.3%	420.8	14.3%	59.9	2.0%	2,259.7	76.9%
Lacamas Creek	1,692.0	34.3	2.0%	176.0	10.4%	141.7	8.4%	1,101.8	65.1%
Lakeshore	15.6	5.3	33.8%	4.5	28.8%	-0.8	-5.1%	8.0	51.1%
Burnt Bridge Creek	12,791.0	2,853.0	22.3%	2,472.0	19.3%	-381.0	-3.0%	5,869.2	45.9%
Columbia Slope	12,560.3	2,234.1	17.8%	2,505.6	19.9%	271.5	2.2%	5,141.8	40.9%


Additional Acres Required to Meet Canopy Goals by Zoning Category
1,200.0
1,000.0
800.0
600.0
400.0
200.0
0.0
975.5
50.6
162.7
635.0
579.1
79.6
Commercial
Industrial
ROW
Low Density Residential
Medium Density Residential
High Density Residential

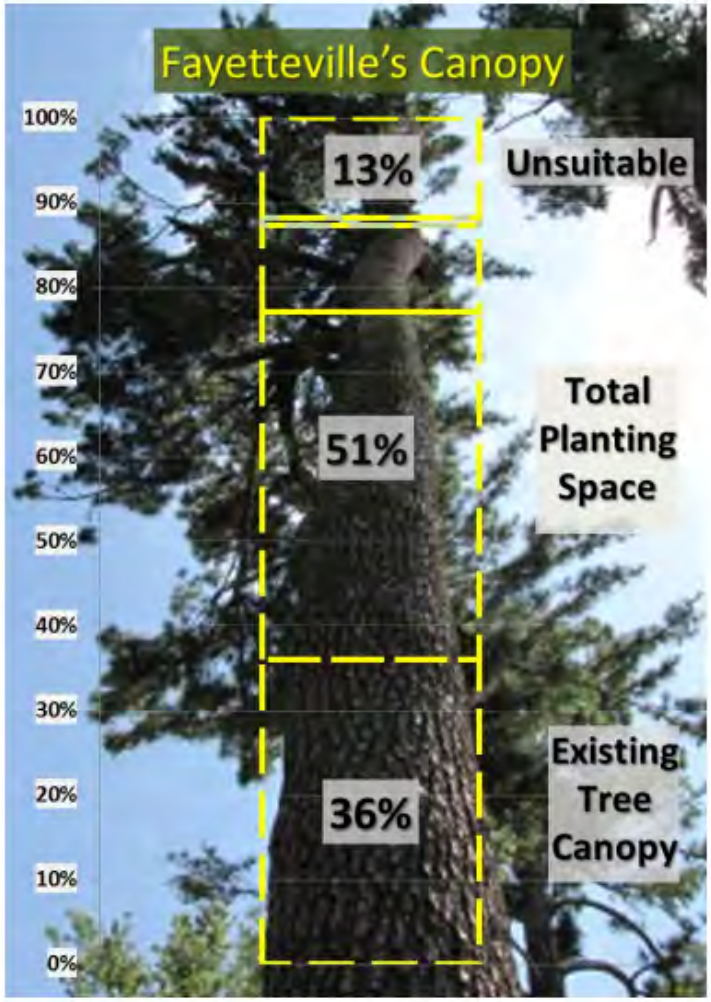

Fayetteville
ARKANSAS


Fayetteville
ARKANSAS
Fayetteville City Limits
Tree Canopy
0 1 2 Miles
0 1 2 Kilometers
N



	Land Use Category	Total Acres	Land Area (acres)	% of Total City Area	UTC (acres)	Existing UTC %	Distribution of UTC by Land Use	Total Possible Planting (acres)	Total Possible Planting %	Distribution of Total PPA by Land Use
City of Fayetteville	Agriculture	9,880	9,757	27.9%	4,353	44.6%	35.0%	5,329	54.6%	29.5%
	Commercial	3,985	3,943	11.2%	702	17.8%	5.6%	2,705	68.6%	15.0%
	Industrial	957	949	2.7%	258	27.2%	2.1%	549	57.9%	3.0%
	Public Land	6,731	6,106	19.0%	2,285	37.4%	18.4%	3,190	52.2%	17.7%
	Residential	11,017	10,968	31.1%	4,475	40.8%	36.0%	5,038	45.9%	27.9%
	Public Right Of Way	2,867	2,863	8.1%	368	12.9%	3.0%	1,247	43.6%	6.9%
	TOTALS	**35,437**	**34,586**	**100.0%**	**12,441**	**36.0%**	**100.0%**	**18,058**	**52.2%**	**100.0%**

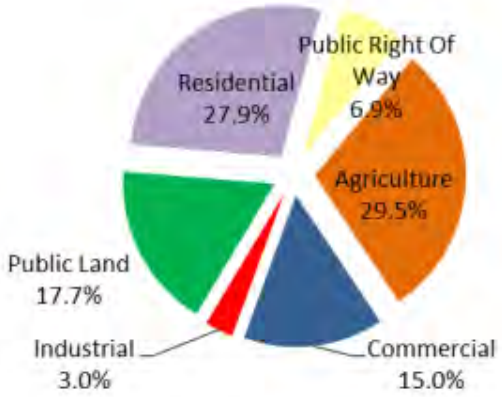
	Total Acres	Land Area (acres)	2010 UTC (acres)	2010 UTC %
City of Fayetteville	35,437	34,586	12,441	36.0%



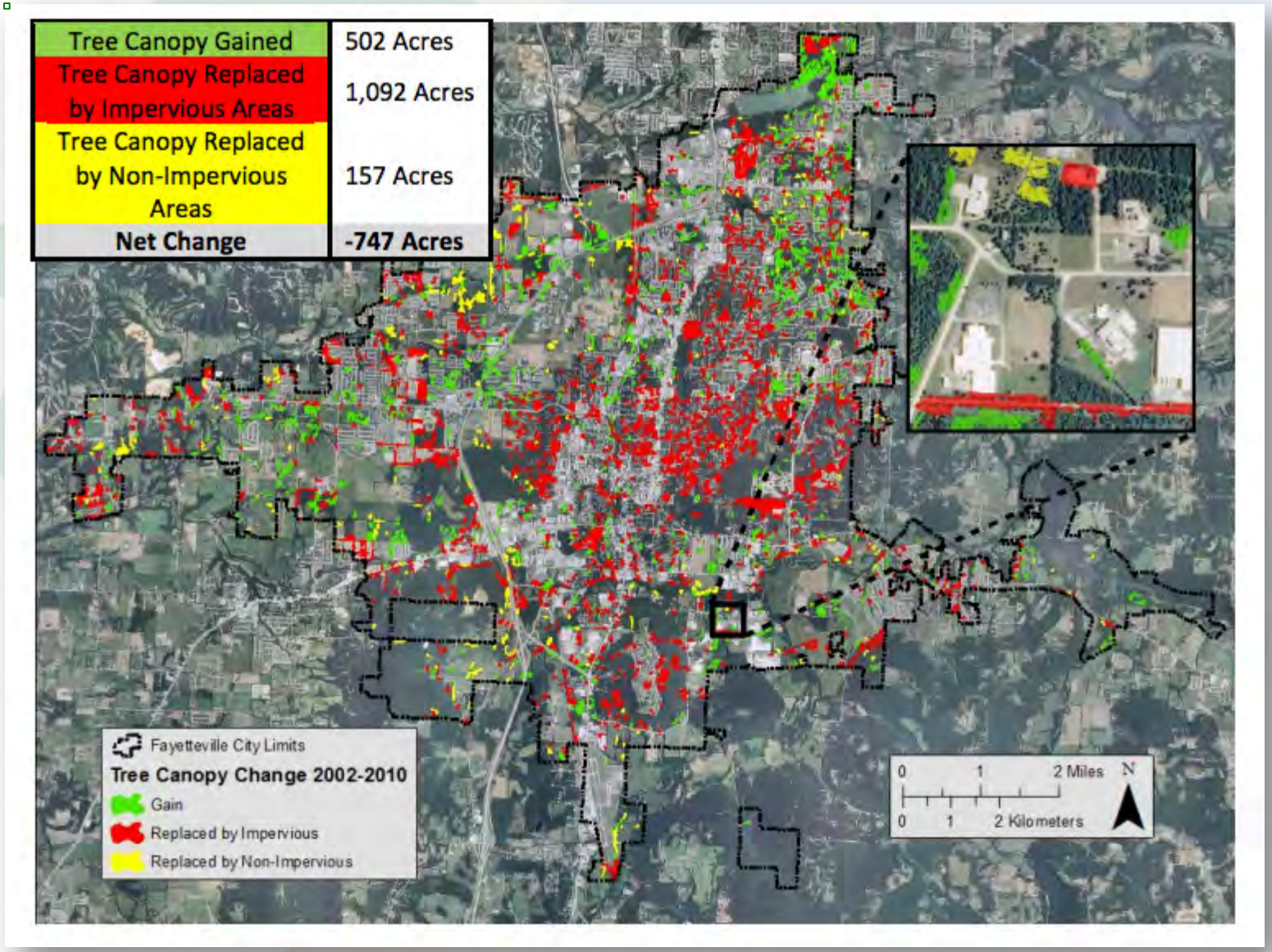
Distribution of Land Use

Distribution of Existing UTC by Land Use

Distribution of Total PPA by Land Use




60%
50%
40%
30%
20%
10%
0%
by 2036
50%
41%
by 2036
40%
20%
by 2036
56%
43%
by 2037
45%
41%
by 2038
20%
12%
by 2031
40%
27%
by 2030
30%
24%
by 2013
40%
35%
Annapolis, MD
Baltimore City, MD
Columbia, PA
Fairfax County, VA
Frederick County, MD Public Schools
Leesburg, VA
New York City, NY
Roanoke, VA
Existing UTC
UTC Goal


Tree Canopy Gained
502 Acres
Tree Canopy Replaced by Impervious Areas
1,092 Acres
Tree Canopy Replaced by Non-Impervious Areas
157 Acres
Net Change
-747 Acres
Fayetteville City Limits
Tree Canopy Change 2002-2010
Gain
Replaced by Impervious
Replaced by Non-Impervious
0 1 2 Miles
0 1 2 Kilometers
N

City of Fayetteville "Tree Canopy & Environmental Benefit Scenarios"

Benefit Type			SCENARIOS				
	UTC-%	Citywide 36%	Decline to 30%	Increase #1 to 40%	Increase #2a to 45%	Increase #2b to 45%	Residential 41%
Air Quality	*Annual $ Benefit*	$3.5 million	$3.0 million	$4.0 million	$4.5 million	$5.0 million	$1.3 million
	Lbs. Removed/Year	1.3 million	1.1 million	1.4 million	1.6 million	1.8 million	461,000
Carbon Storage & Sequestration	*Total CO2 stored*	1.1 billion	915 million	1.2 billion	1.4 billion	1.5 billion	391 million
	Annual Rate Stored	8.4 million	7.1 million	9.5 million	10.7 million	11.9 million	3.0 million
Stormwater Savings	*Total $ Benefit*	$64.1 million	$43.9 million	$65.5 million *	$67.1 million *	$84.9 million **	$22.2 million
	Total Gallons Benefit . . .	21.4 million	14.6 million	21.9 million	22.4 million	28.3 million	7.4 million

* For Scenarios "Increase #1 and #2a", new projected tree canopy was assumed to be forests (natural regeneration), not individual yard trees.
** For the Scenario "Increase #2b", new projected tree canopy was assumed to overhang impervious surfaces, resulting in a larger $ value.

Holyoke, MA

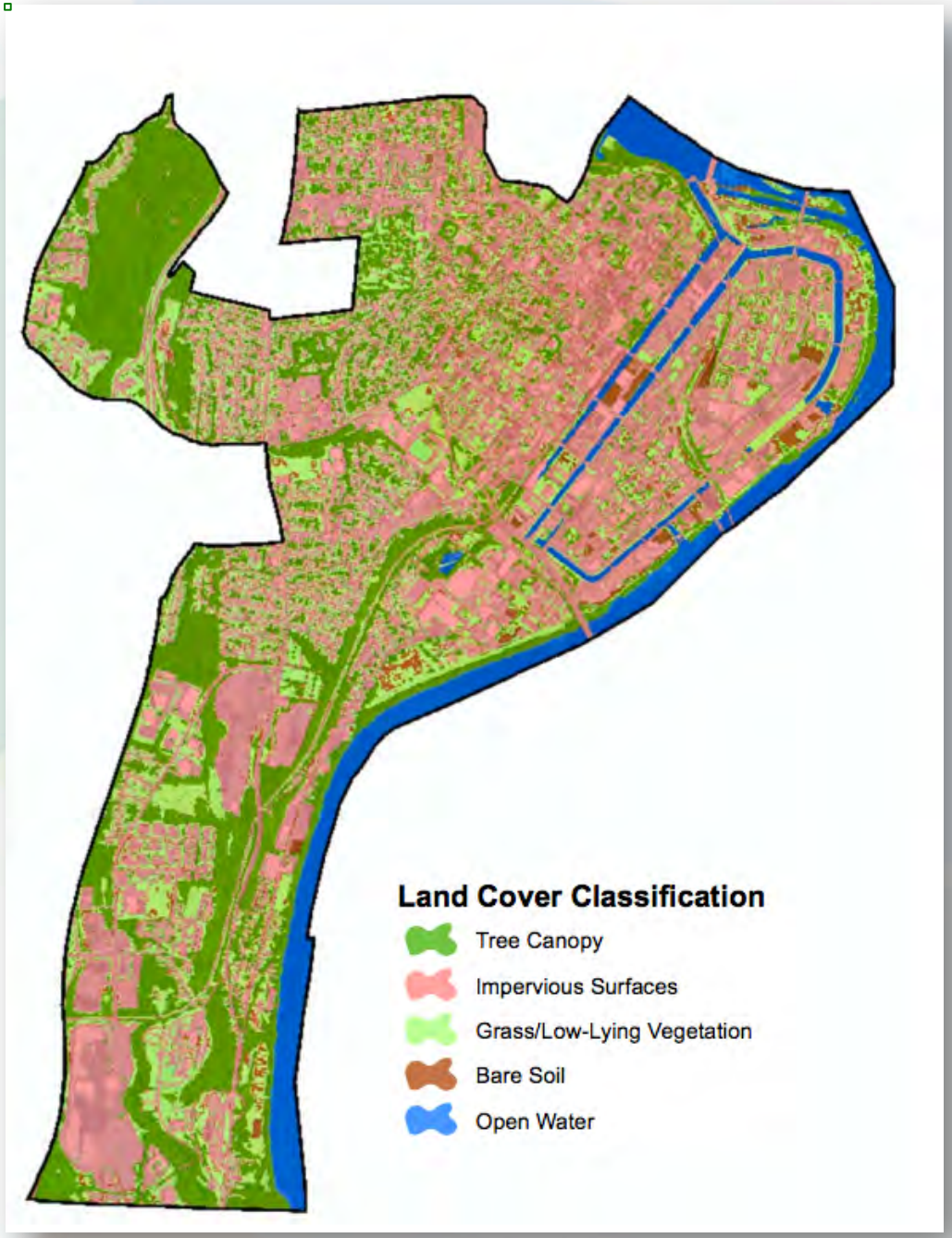
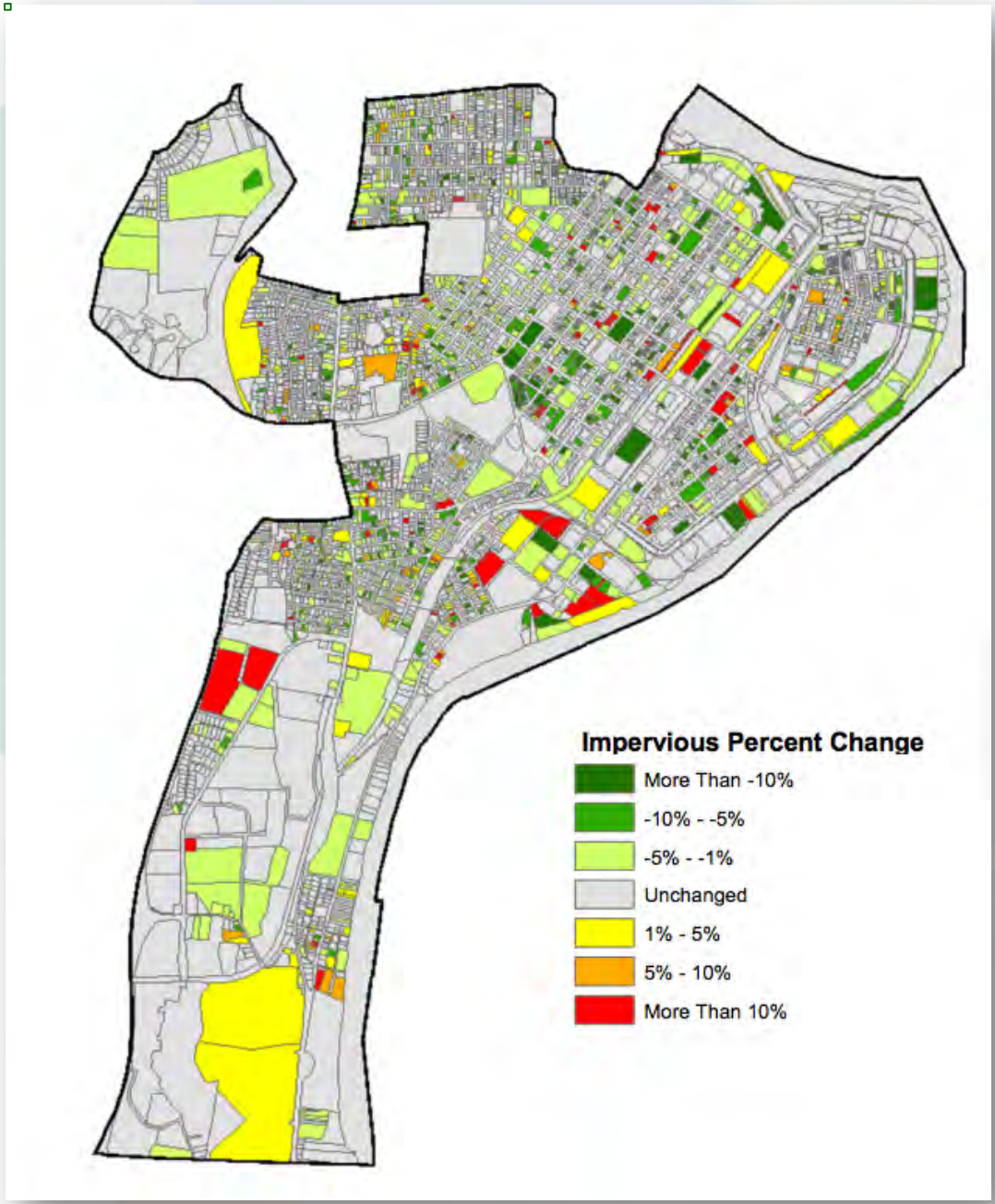

Land Cover Classification
Tree Canopy
Impervious Surfaces
Grass/Low-Lying Vegetation
Bare Soil
Open Water

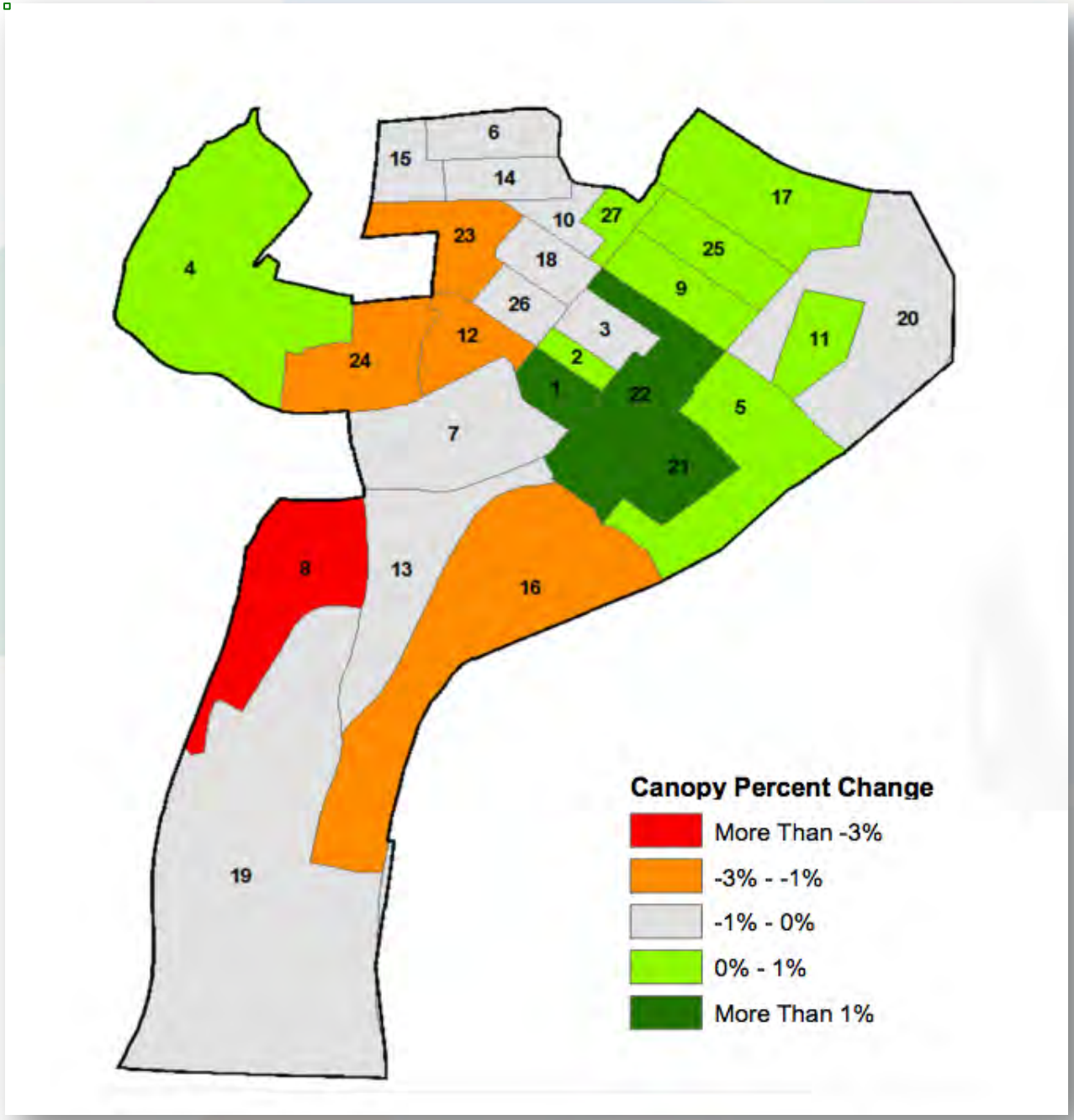
Table 1. 2012 Land Cover Classification

Land Cover Classification	Acres	Percentage
Total Area	3,367.87	100
Tree Canopy	893.18	26.52
Impervious		
Pervious		
Bare Soil		
Open Water		

Table 3. Change in Canopy Cover as Percent by Parcel in Holyoke's Environmental Justice Area

Percent Change	Number of Parcels
More Than −10%	192
−10% – −5%	60
−5% – −1 %	81
Unchanged	4,961
1% – 5%	144
5% – 10%	54
More Than 10%	36


Impervious Percent Change
More Than -10%
-10% - -5%
-5% - -1%
Unchanged
1% - 5%
5% - 10%
More Than 10%


6
15
14
10
27
17
23
25
18
4
9
26
20
12
3
11
24
2
1
22
5
7
21
8
13
16
19
Canopy Percent Change
More Than -3%
-3% - -1%
-1% - 0%
0% - 1%
More Than 1%

Urban Tree Canopy (UTC)

New England

USDA

United States
Department of
Agriculture

Forest Service

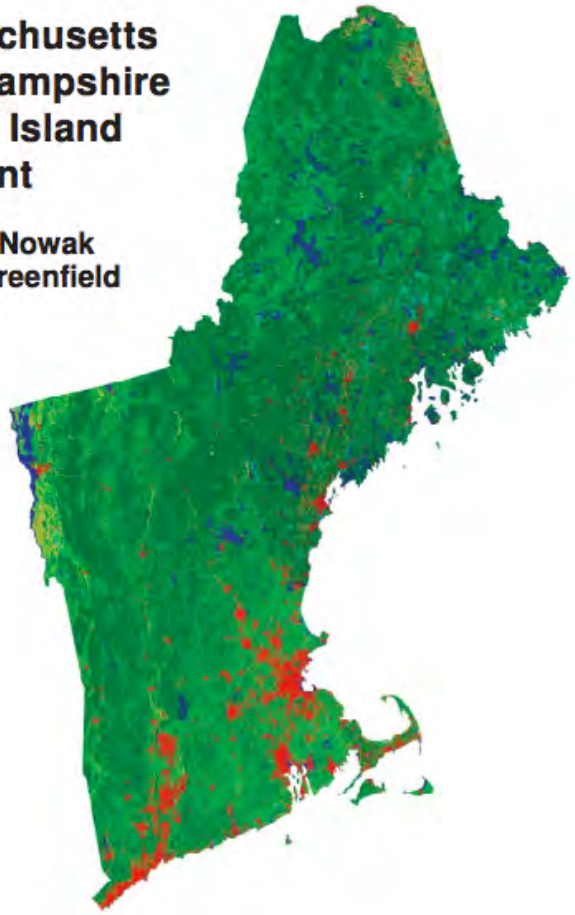
**Northern
Research Station**

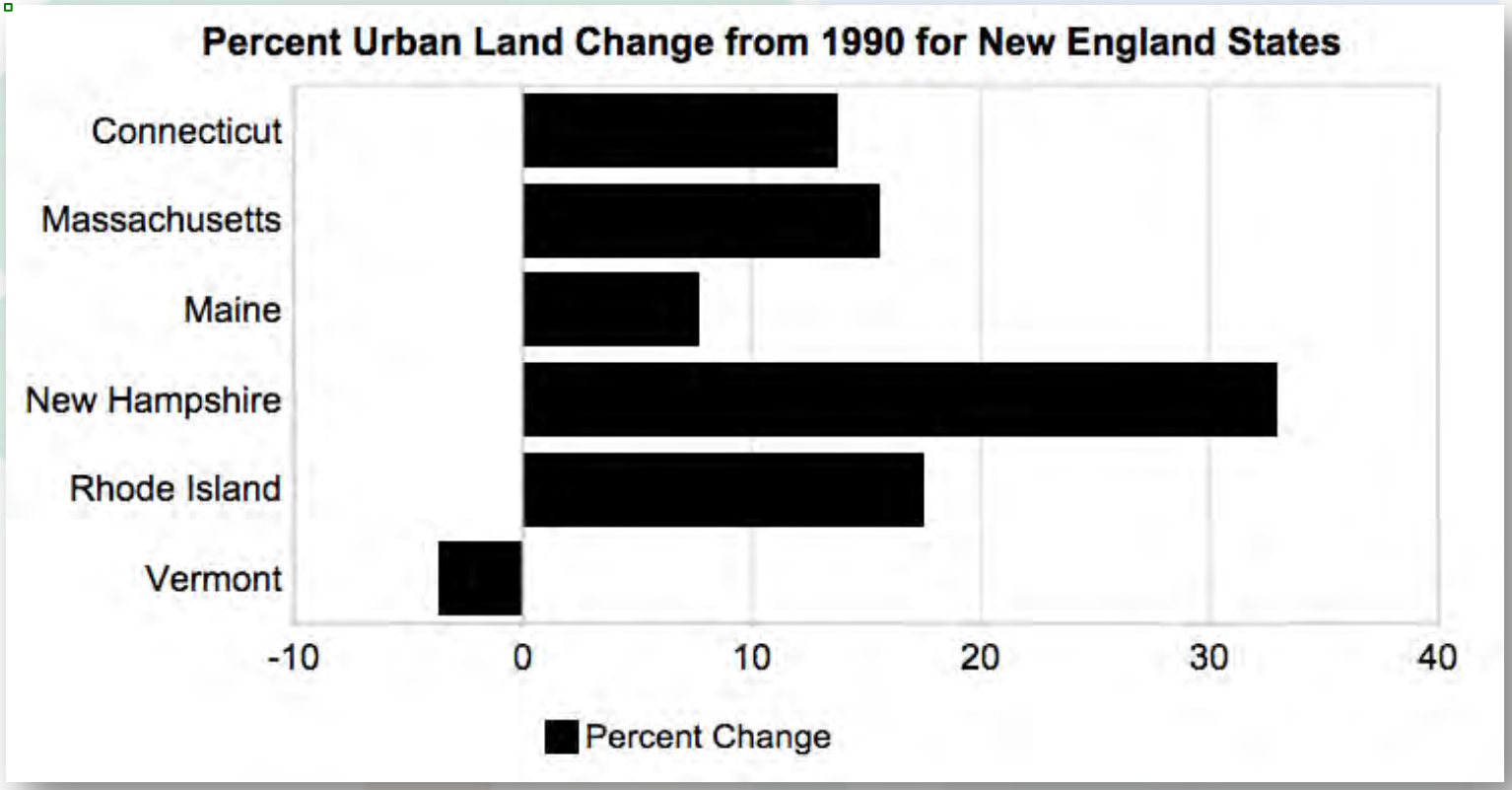
General Technical
Report NRS-38

Urban and Community Forests of New England

Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont

**David J. Nowak
Eric J. Greenfield**




Percent Urban Land Change from 1990 for New England States
Connecticut
Massachusetts
Maine
New Hampshire
Rhode Island
Vermont
-10
0
10
20
30
40
Percent Change

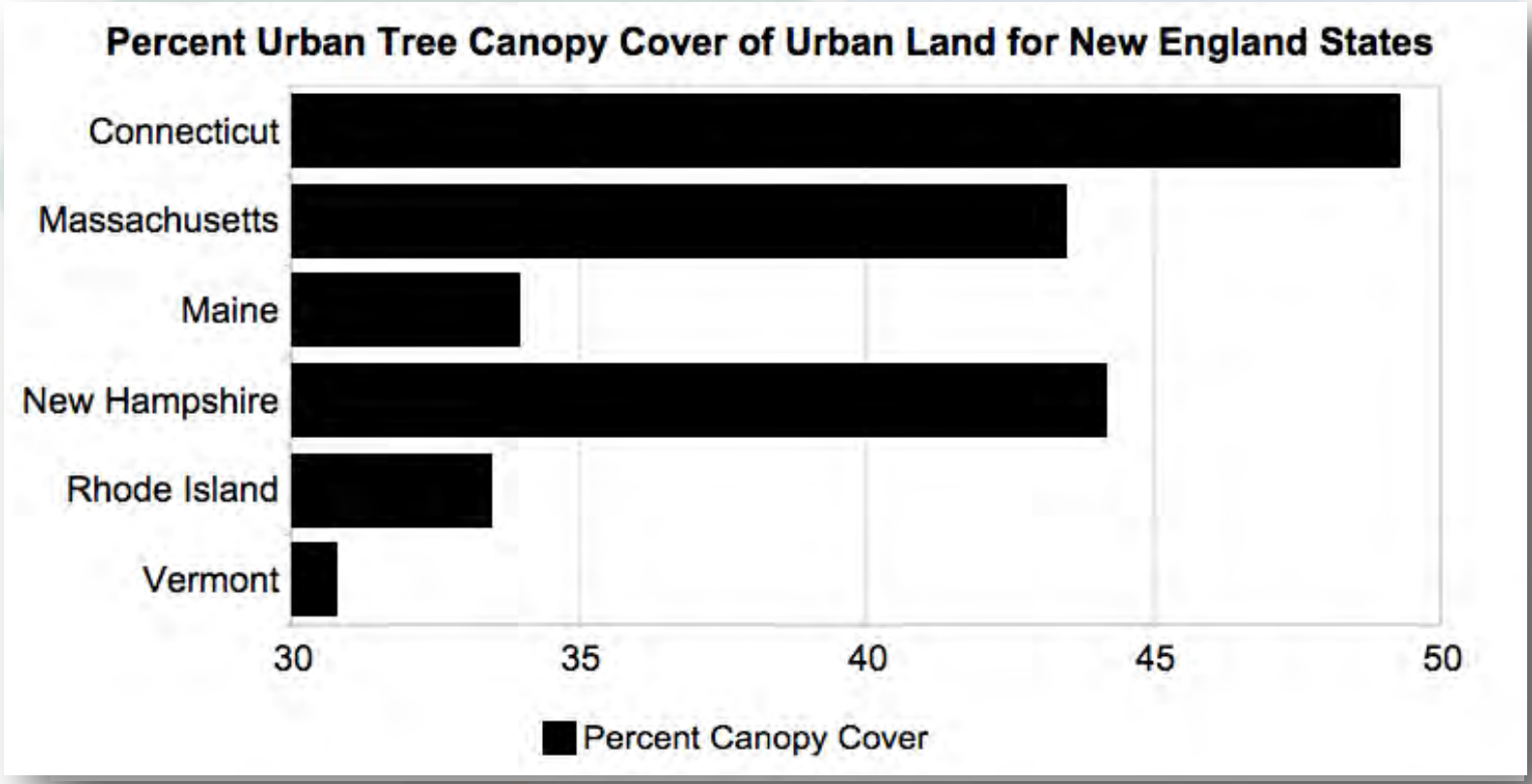
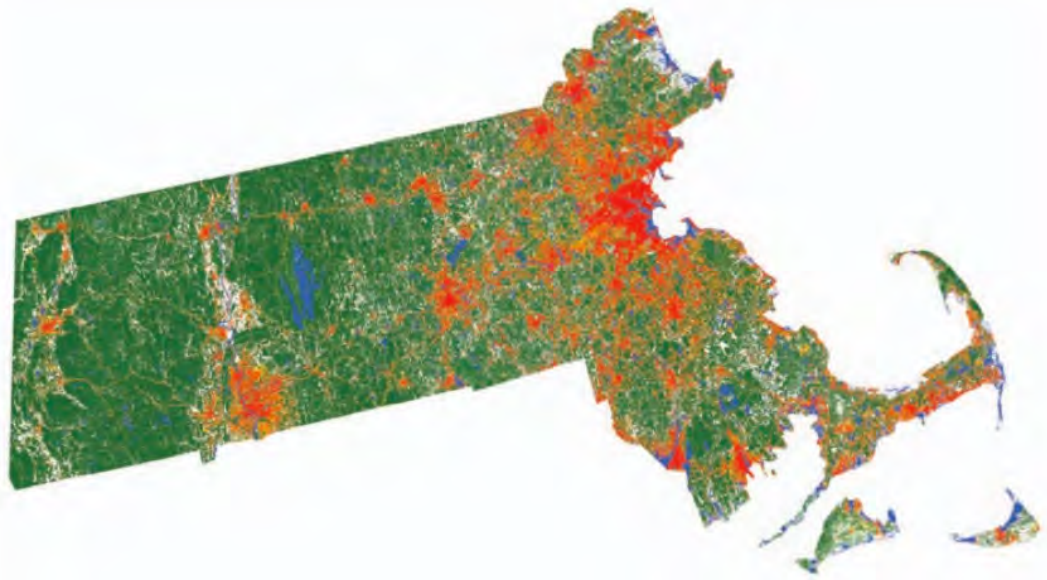

Percent Urban Tree Canopy Cover of Urban Land for New England States
Connecticut
Massachusetts
Maine
New Hampshire
Rhode Island
Vermont
30
35
40
45
50
Percent Canopy Cover

Table A.—Average number of trees, carbon storage, and carbon sequestration rates per unit of canopy cover for several U.S. cities

City	Trees (no./ha cover)	Carbon Storage (kg C/m^2 cover)	Carbon Sequestration (kg C/m^2 cover)
Atlanta, GA [a]	751.5	9.7	0.3
Baltimore, MD [a]	598.1	12.3	0.3
Boston, MA [a]	371.7	9.1	0.3
Chicago, IL [b]	618	12.9	n/a
Casper, WY [c]	252.8	7	0.2
Freehold, NJ [a]	275	10.4	0.3
Jersey City, NJ [a]	308.7	4.4	0.2
Minneapolis, MN [d]	245.5	5.7	0.2
Moorestown, NJ [a]	547.9	9.9	0.3
Morgantown, WV [a]	829.6	10.6	0.3
New York, NY [e]	312	7.3	0.2
Philadelphia, PA [f]	394.3	9	0.3
San Francisco, CA [g]	468.1	12.3	0.3
Syracuse, NY [h]	583.1	10.5	0.3
Oakland, CA [i]	570	5.2	n/a
Washington, DC [j]	423.4	10.4	0.3
Woodbridge, NJ [a]	557.3	8.2	0.3
Mean	476.9	9.1	0.3



MASSACHUSETTS' URBAN AND COMMUNITY FORESTS

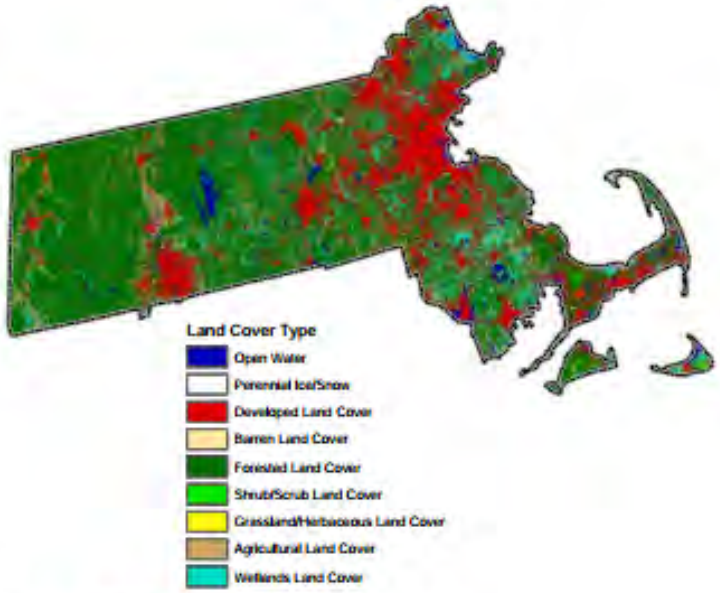


Figure MA-9.—Classified land cover.

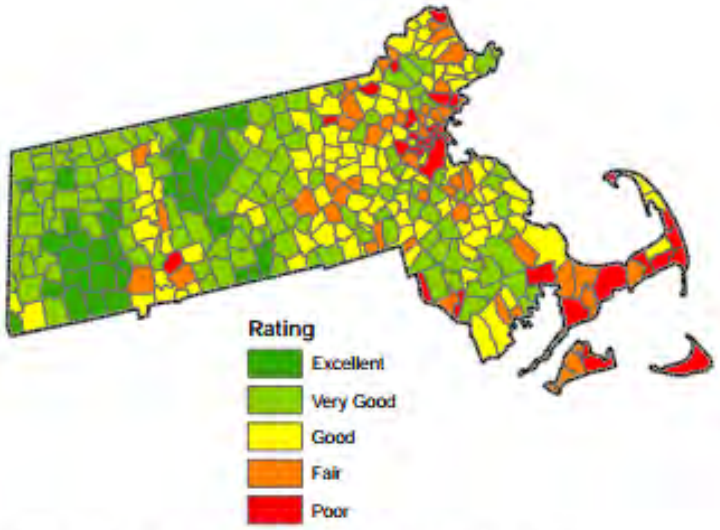


Figure MA-10.—Relative comparisons of urban and community forests for county subdivisions.

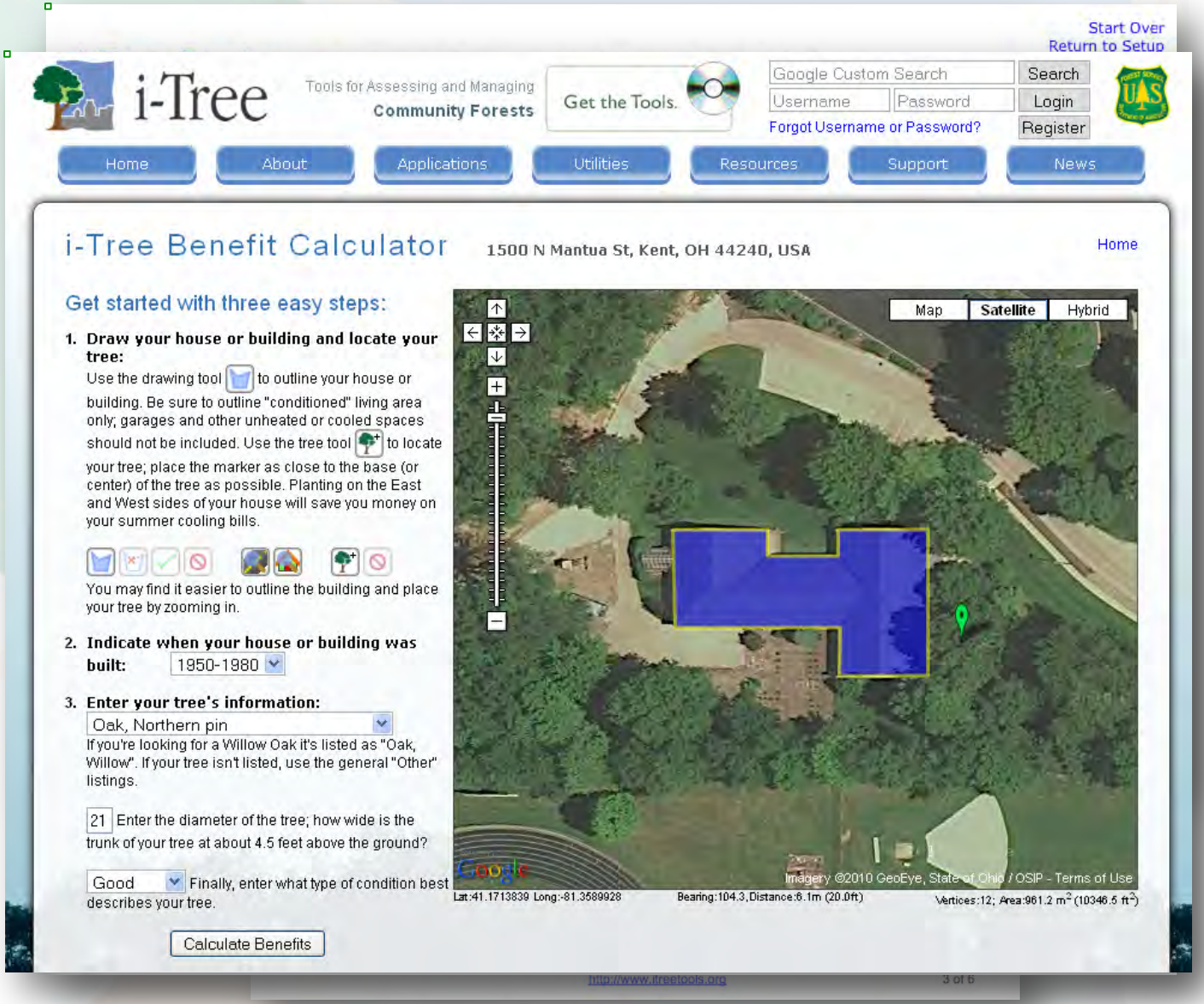
Urban tree benefits (2000)		Statewide	Urban	Community	Urban or Community
	Estimated number of trees	n/a	150,200,000	87,500,000	178,000,000
	Carbon				
	Carbon stored (metric tons)	n/a	28,700,000	16,700,000	34,000,000
	Carbon stored ($)	n/a	$654,400,000	$380,800,000	$775,200,000
	Carbon sequestered (metric tons/year)	n/a	945,000	551,000	1,120,000
	Carbon sequestered ($/year)	n/a	$21,546,000	$12,563,000	$25,536,000
	Pollution				
	CO removed (metric tons/year)	n/a	586	342	695
	CO removed ($/year)	n/a	$824,900	$480,900	$977,700
	NO_2 removed (metric tons/year)	n/a	3,619	2,110	4,289
	NO_2 removed ($/year)	n/a	$35,848,600	$20,898,500	$42,488,700
	O_3 removed (metric tons/year)	n/a	13,201	7,696	15,646
	O_3 removed ($/year)	n/a	$130,770,000	$76,234,000	$154,992,000
	SO_2 removed (metric tons/year)	n/a	1,635	953	1,938
	SO_2 removed ($/year)	n/a	$3,965,100	$2,311,500	$4,699,600
	PM_{10} removed (metric tons/year)	n/a	5,304	3,092	6,286
	PM_{10} removed ($/year)	n/a	$35,079,900	$20,450,300	$41,577,600
	Total pollution removal (metric tons/year)	n/a	24,350	14,190	28,850
	Total pollution removal ($/year)	n/a	$206,500,000	$120,400,000	$244,700,000

[a] Urban land is based on population density and was delimited using the U.S. Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on U.S. Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space is total area minus impervious surface cover minus water. [f] Available green space is total green space minus tree canopy cover (if the calculated value is less than 0, then value set at 0).

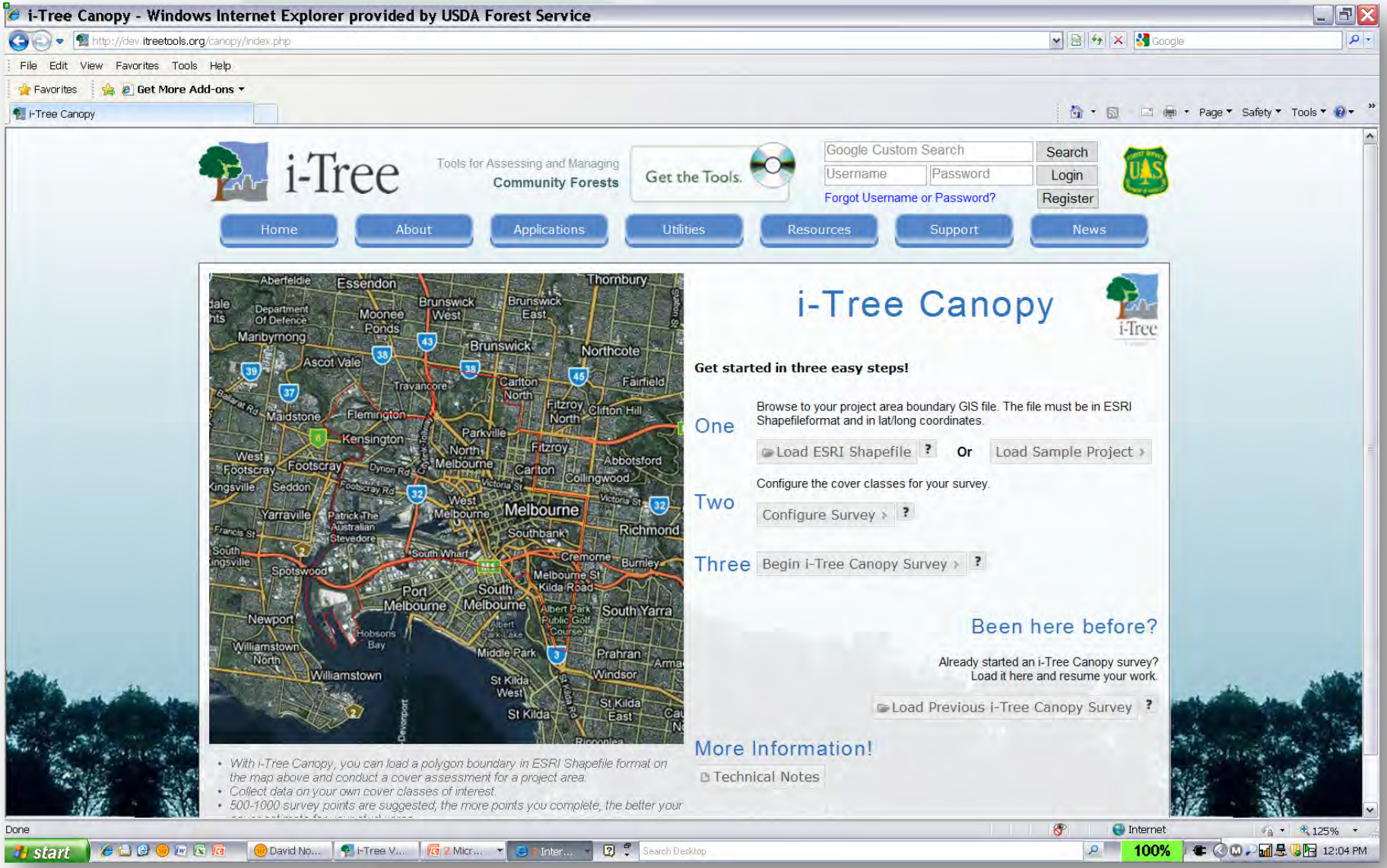
I-Tree Software Tools

Getting started with inventory and analysis in your community

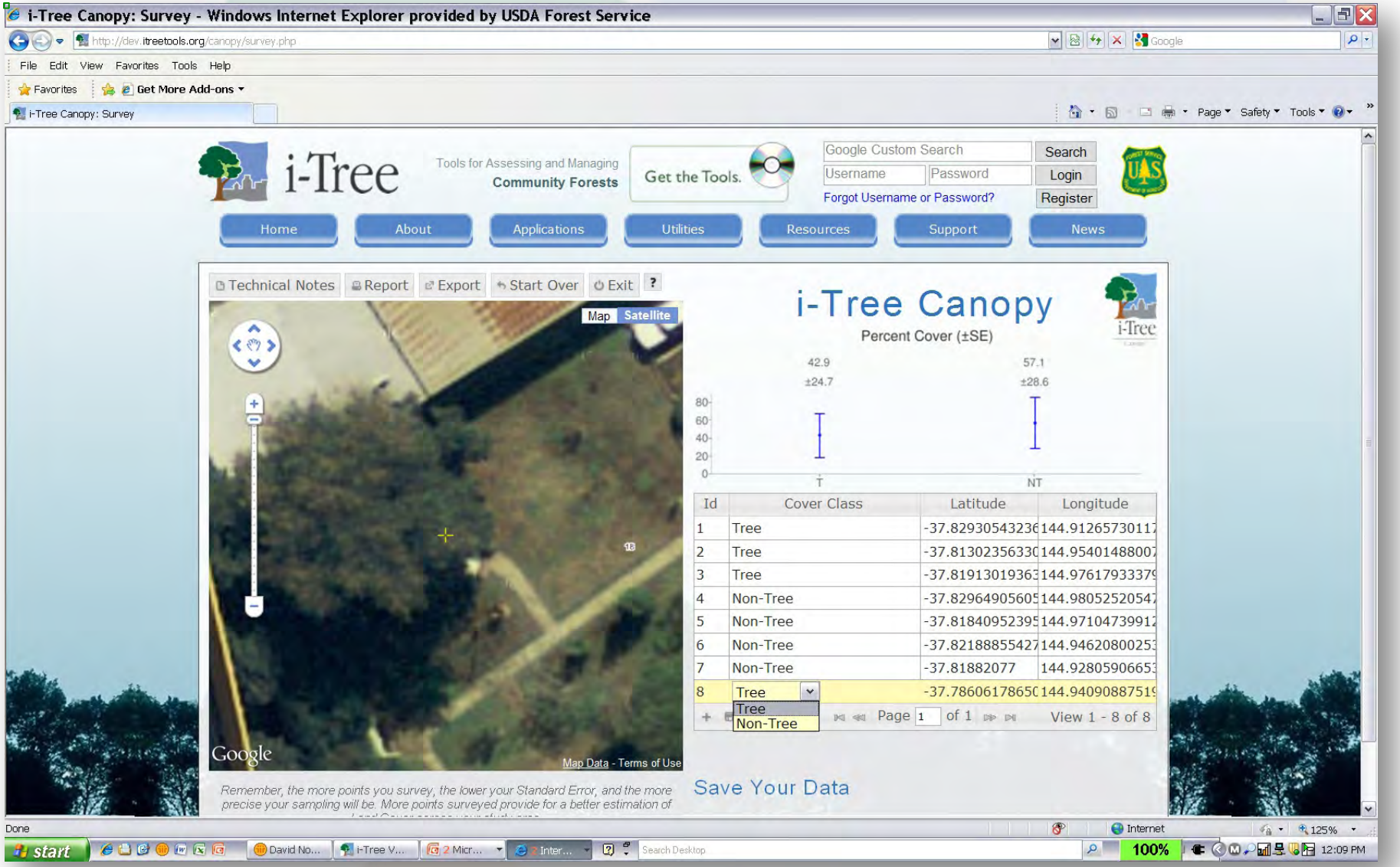
i-Tree Design



i-Tree Canopy



Classify random points



File Edit View History Bookmarks Tools Help

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

i-Tree Canopy: Survey

i-Tree

Tools for Assessing and Managing **Community Forests**

Get the Tools.

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Username | Password | Login

Forgot Username or Password? | Register

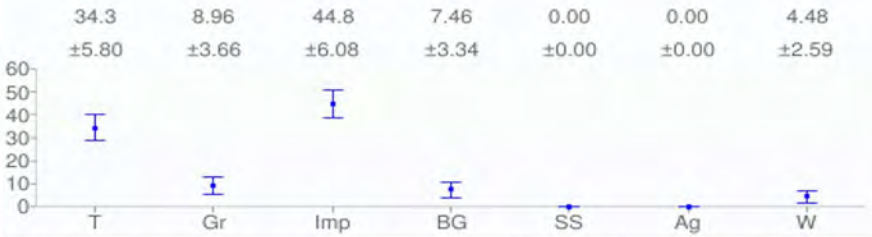
Home | About | Applications | Utilities | Resources | Support | News

Technical Notes | Report | Export | Start Over | Exit | ?

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.

i-Tree Canopy

Percent Cover (±SE)



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		38.888206252128	-76.951066339859
66		38.891553823381	-77.04287817671
67		38.907230806429	-77.049487697045

Tree
Grass
Impervious
Bare Ground
Shrub/Scrub
Agriculture
Water
Other

Page 7 of 7 View 61 - 67 of

Save Your Data

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

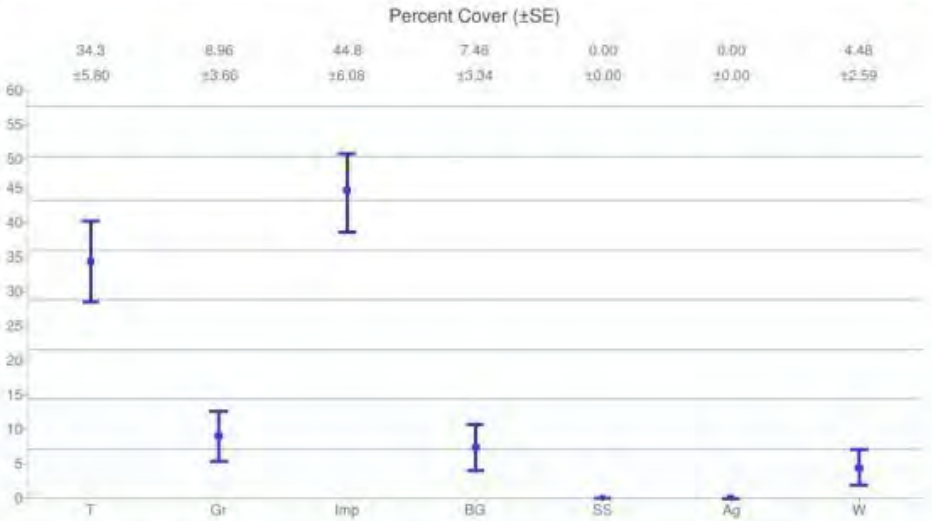
File Edit View History Bookmarks Tools Help

http://www.itreetools.org/canopy/report.php

i-Tree Canopy: Cover Report

i-Tree Canopy

Cover Report



Cover Class	Description	Abbr.	% Cover
Tree	tree, non-shrub	T	34.3 ±5.80
Grass	herbaceous ground cover	Gr	8.96 ±3.66
Impervious	artificial surfaces	Imp	44.8 ±6.08
Bare Ground	soil or barren	BG	7.46 ±3.34
Shrub/Scrub	non tree woody land cover	SS	0.00 ±0.00
Agriculture	crops, pasture, hay	Ag	0.00 ±0.00
Water	lakes, streams	W	4.48 ±2.59
Other	other land cover	O	0.00 ±0.00

About i-Tree Canopy

The concept and prototype of this program were developed by David J. Nowak, Jeffery T. Walton and Eric J. Greenfield (USDA Forest Service). The current version of this program was developed and adapted to i-Tree by David Ellingsworth, Mike Binkley, and Scott Maco (The Davey Tree Expert Company).

Limitations of i-Tree Canopy

The accuracy of the analysis depends upon the ability of the user to correctly classify each point into its correct class. As the number of points increase, the precision of the estimate will increase as the standard error of the estimate will decrease. If too few points are classified, the standard error will be too high to have any real certainty of the estimate.

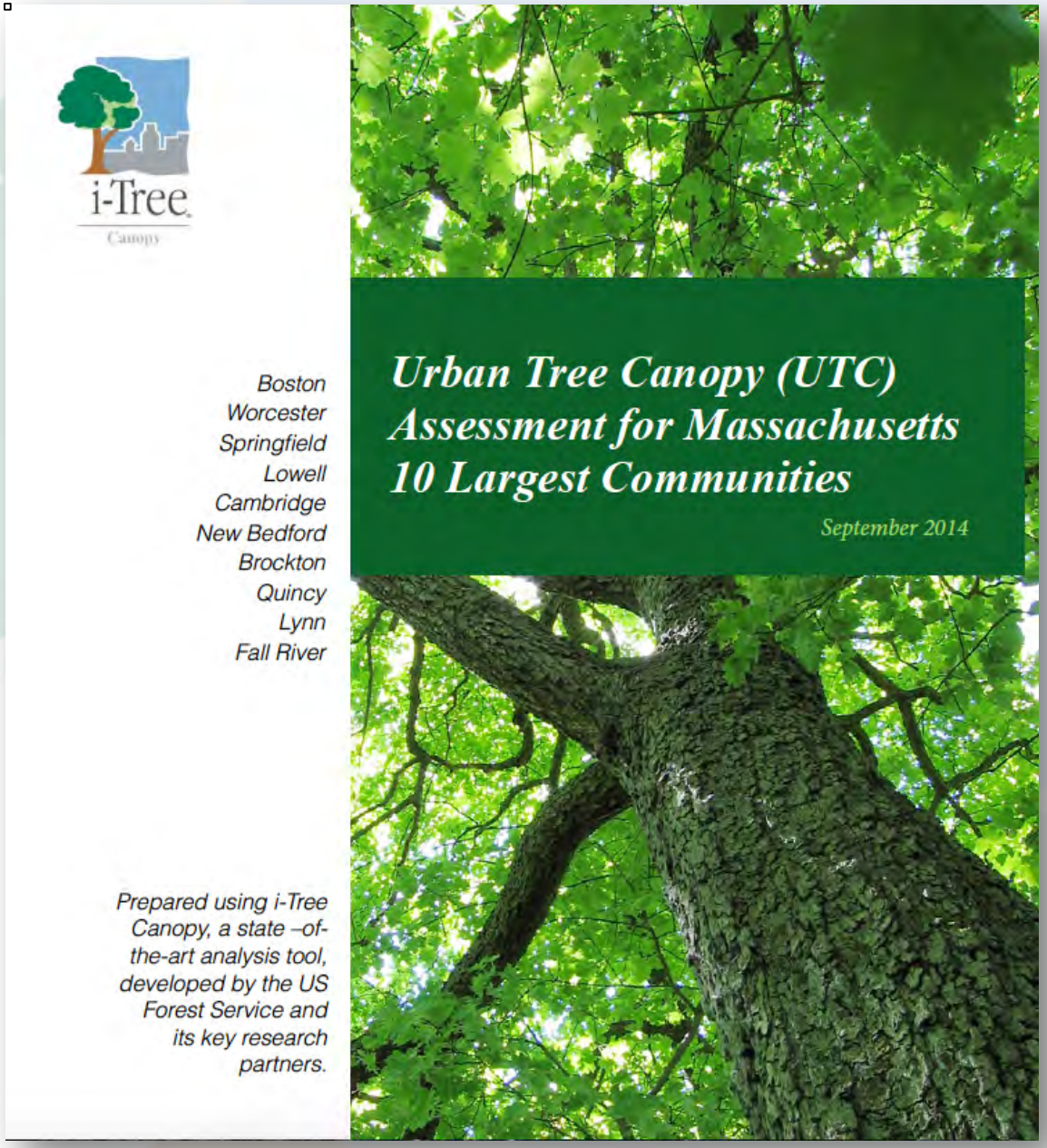
A Cooperative Initiative Between:

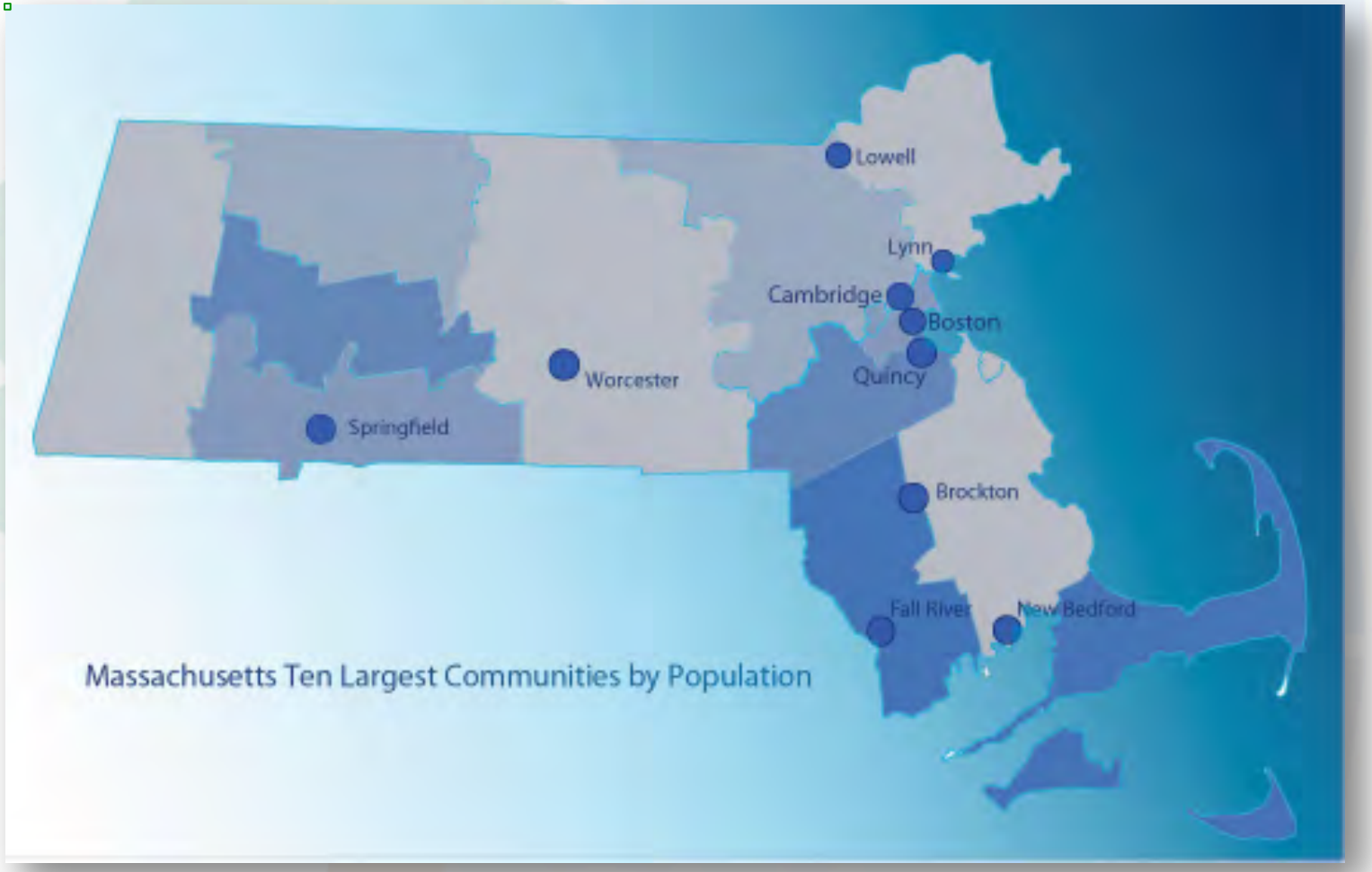
DAVEY Arbor Day Foundation SMA ISA Casey Trees

‹ Back


Exit 13

i-Tree


i-Tree
Canopy
Boston
Worcester
Springfield
Lowell
Cambridge
New Bedford
Brockton
Quincy
Lynn
Fall River
Urban Tree Canopy (UTC) Assessment for Massachusetts 10 Largest Communities
September 2014
Prepared using i-Tree Canopy, a state –of-the-art analysis tool, developed by the US Forest Service and its key research partners.


Lowell
Lynn
Cambridge
Boston
Quincy
Worcester
Springfield
Brockton
Fall River
New Bedford
Massachusetts Ten Largest Communities by Population

City Size Rank	City	Total Area (Sq. Mi.)	Population
1	Boston	48.26	645,966
2	Worcester	37.37	182,544
3	Springfield	31.87	153,703
4	Lowell	13.58	108,861
5	Cambridge	6.39	107,289
6	New Bedford	20	95,078
7	Brockton	21.33	94,089
8	Qunicy	16.57	93,494
9	Lynn	10.74	91,589
10	Fall River	33.13	88,697

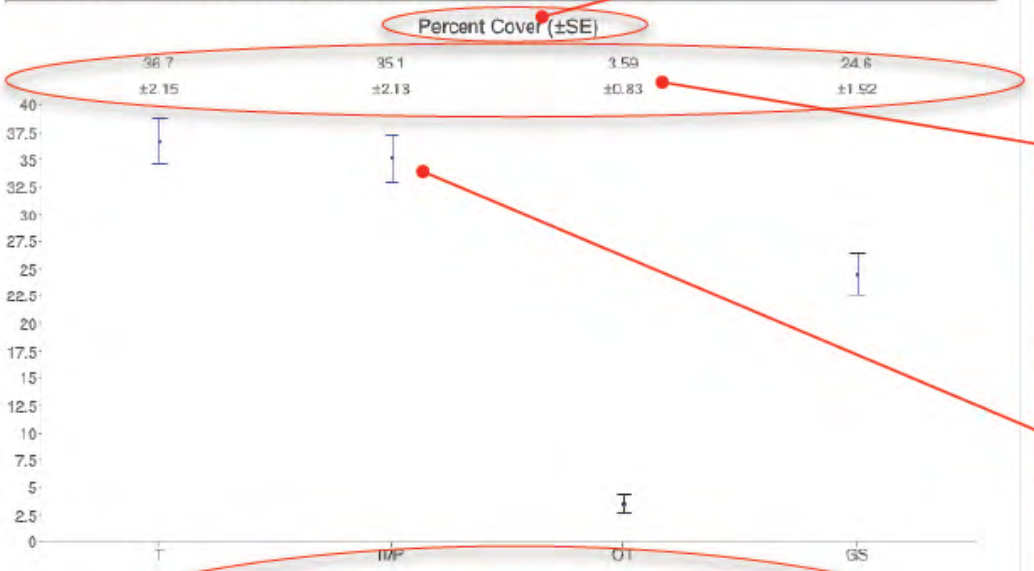
i-Tree

Tools for Assessing and Managing
Community Forests

i-Tree Canopy v6.0

Cover Assessment and Tree Benefits Report

Estimated using random sampling statistics on 3/28/14



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	184	36.7 ±2.15
Impervious Surface	impervious surfaces	IMP	176	35.1 ±2.13
Other	other areas i.e.:gravel	OT	18	3.59 ±0.83
Grass and Shrubs	grass and shrubs	GS	123	24.6 ±1.92

Reporting Value - % or Area

Standard Error

Confidence Intervals

Cover Class Reporting

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$289.62	±16.98	3.42 T	±0.20
NO2	Nitrogen Dioxide removed annually	$498.62	±29.24	18.63 T	±1.09
O3	Ozone removed annually	$25,906.92	±1,522.73	185.52 T	±10.88
PM2.5	Particulate Matter less than 2.5 microns removed annually	$53,678.39	±3,147.76	9.01 T	±0.53
SO2	Sulfur Dioxide removed annually	$87.15	±5.11	11.74 T	±0.68
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$18,851.32	±1,105.46	62.14 T	±3.64
CO2seq	Carbon Dioxide sequestered annually in trees	$719,454.29	±42,189.57	37,155.49 T	±2,178.84
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$21,823,394.55	±1,279,747.12	1,127,047.17 T	±66,091.25

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.902 @ $85.08 | NO2 4.917 @ $26.80 | O3 48.938 @ $140.47 | PM2.5 2.370 @ $5,675.67 | SO2 3.008 @ $7.45 | PM10 16.403 @ $304.43 | CO2seq 9,807.365 @ $19.43 | CO2stor is a total biomass amount of 297,489.061 @ $19.43*
Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.

About i-Tree Canopy

The concept and prototype of this program were developed by David J. Nowak, Jeffery T. Walton and Eric J. Greenfield (USDA Forest Service). The current version of this program was developed and adapted to i-Tree by David Ellingsworth, Mike Binkley, and Scott Maco (The Davey Tree Expert Company).

Limitations of i-Tree Canopy

The accuracy of the analysis depends upon the ability of the user to correctly classify each point into its correct class. As the number of points increase, the precision of the estimate will increase as the standard error of the estimate will decrease. If too few points are classified, the standard error will be too high to have any real certainty of the estimate.

A Cooperative Initiative Between:

DAVEY · Arbor Day Foundation · SMA · ISA · Casey Trees

www.itreetools.org

Amount (Tons)

Dollar Value of Benefits ($)

Boston Urban Forest Canopy Assessment

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$340.09	±19.34	4.01 T	±0.23
NO2	Nitrogen Dioxide removed annually	$585.50	±33.30	21.87 T	±1.24
O3	Ozone removed annually	$30,491.74	±1,734.09	217.84 T	±12.39
PM2.5	Particulate Matter less than 2.5 microns removed annually	$63,032.01	±3,584.69	10.59 T	±0.60
SO2	Sulfur Dioxide removed annually	$102.33	±5.82	13.78 T	±0.78
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$22,136.22	±1,258.91	72.97 T	±4.15
CO2seq	Carbon Dioxide sequestered annually in trees	$844,821.44	±48,045.80	43,629.95 T	±2,481.28
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$25,626,188.94	±1,457,385.70	1,323,438.65 T	±75,265.21

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.902 @ $85.08 | NO2 4.917 @ $26.86 | O3 48.968 @ $140.47 | PM2.5 2.379 @ $5,975.67 | SO2 3.098 @ $7.45 | PM10 16.403 @ $304.43 | CO2seq 9,807.385 @ $19.43 | CO2stor is a total biomass amount of 297,489.961 @ $19.43*
Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.

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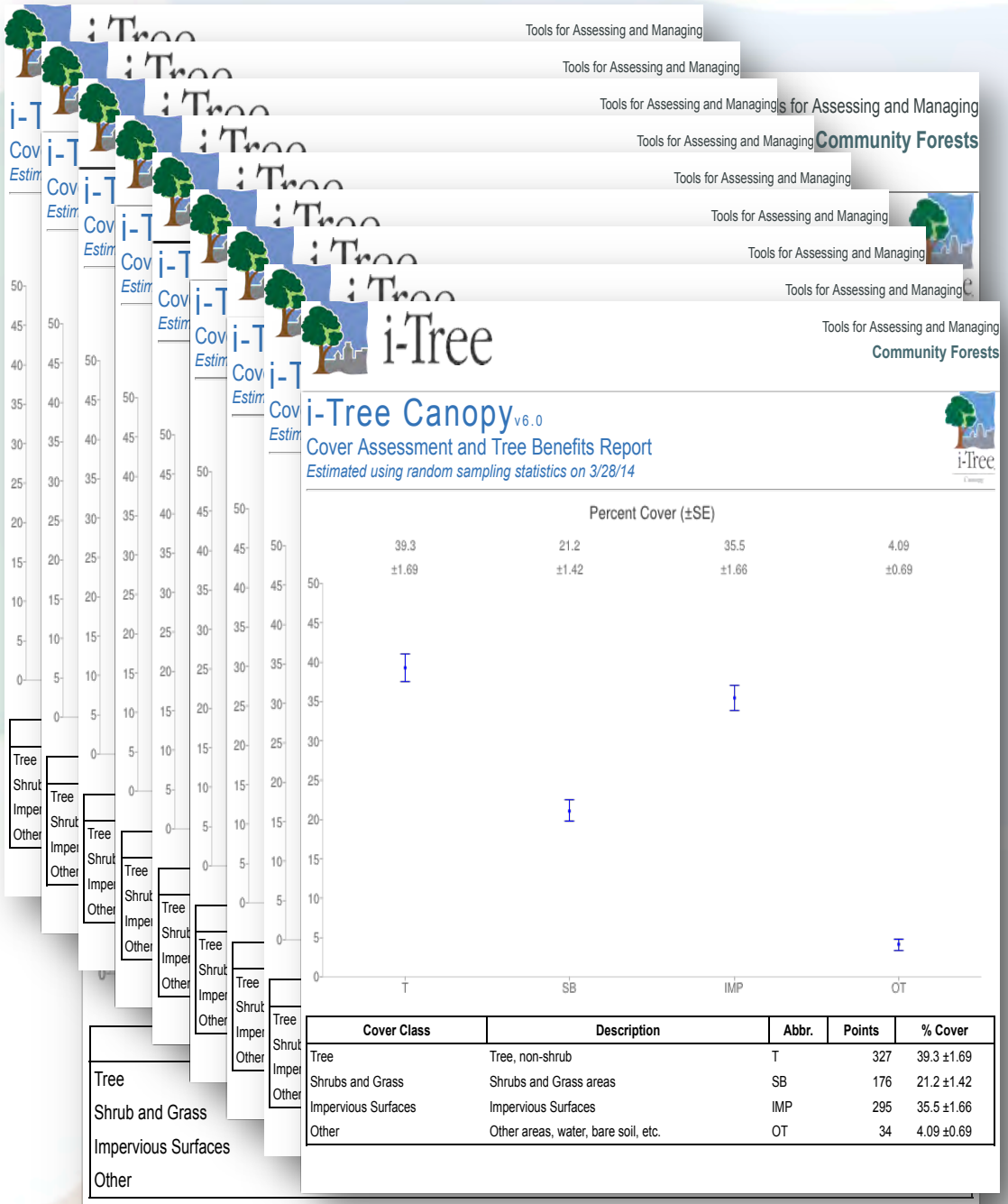
A Cooperative Initiative Between:

DAVEY Arbor Day Foundation SMA Society of Municipal Arborists ISA Casey Trees Washington DC

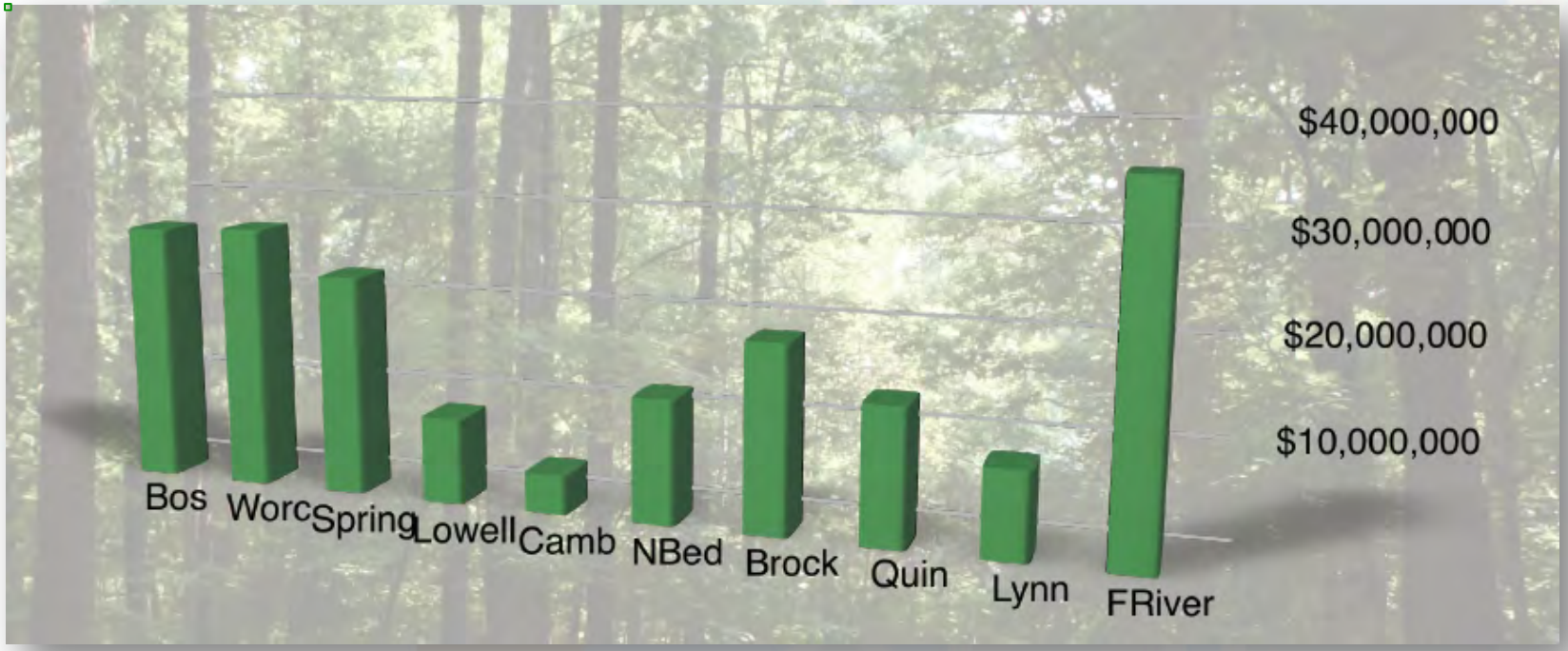
www.itreetools.org

Impervious Surfaces	IS	373	46.6 ±1.76
Other	O	83	10.4 ±1.08



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	327	39.3 ±1.69
Shrubs and Grass	Shrubs and Grass areas	SB	176	21.2 ±1.42
Impervious Surfaces	Impervious Surfaces	IMP	295	35.5 ±1.66
Other	Other areas, water, bare soil, etc.	OT	34	4.09 ±0.69

City Size Rank	City	% Canopy Cover	Report by Area (mi
1	Boston	27.9	13.9
2	Worcester	39.3	14.1
3	Springfield	36.7	11.8
4	Lowell	31	4.59
5	Cambridge	34	2.08
6	New Bedford	32.8	6.58
7	Brockton	45.9	9.88
8	Qunicy	43.1	7.21
9	Lynn	40.5	4.58
10	Fall River	59.3	18.7


$40,000,000
$30,000,000
$20,000,000
$10,000,000
Bos
Worc
Spring
Lowell
Camb
NBed
Brock
Quin
Lynn
FRiver


Tree Canopy Cover 34%
Tree Cover (sq. mi.) 2.08
Tree Canopy Cover Value
$ 3984187.41
Tree Canopy Cover 31%
Tree Cover (sq. mi.) 4.59
Tree Canopy Cover Value
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Tree Canopy Cover 40.5%
Tree Cover (sq. mi.) 4.58
Tree Canopy Cover Value
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Lowell
Lynn
Cambridge
Boston
Tree Canopy Cover 27.9%
Tree Cover (sq. mi.) 13.9
Tree Canopy Cover Value
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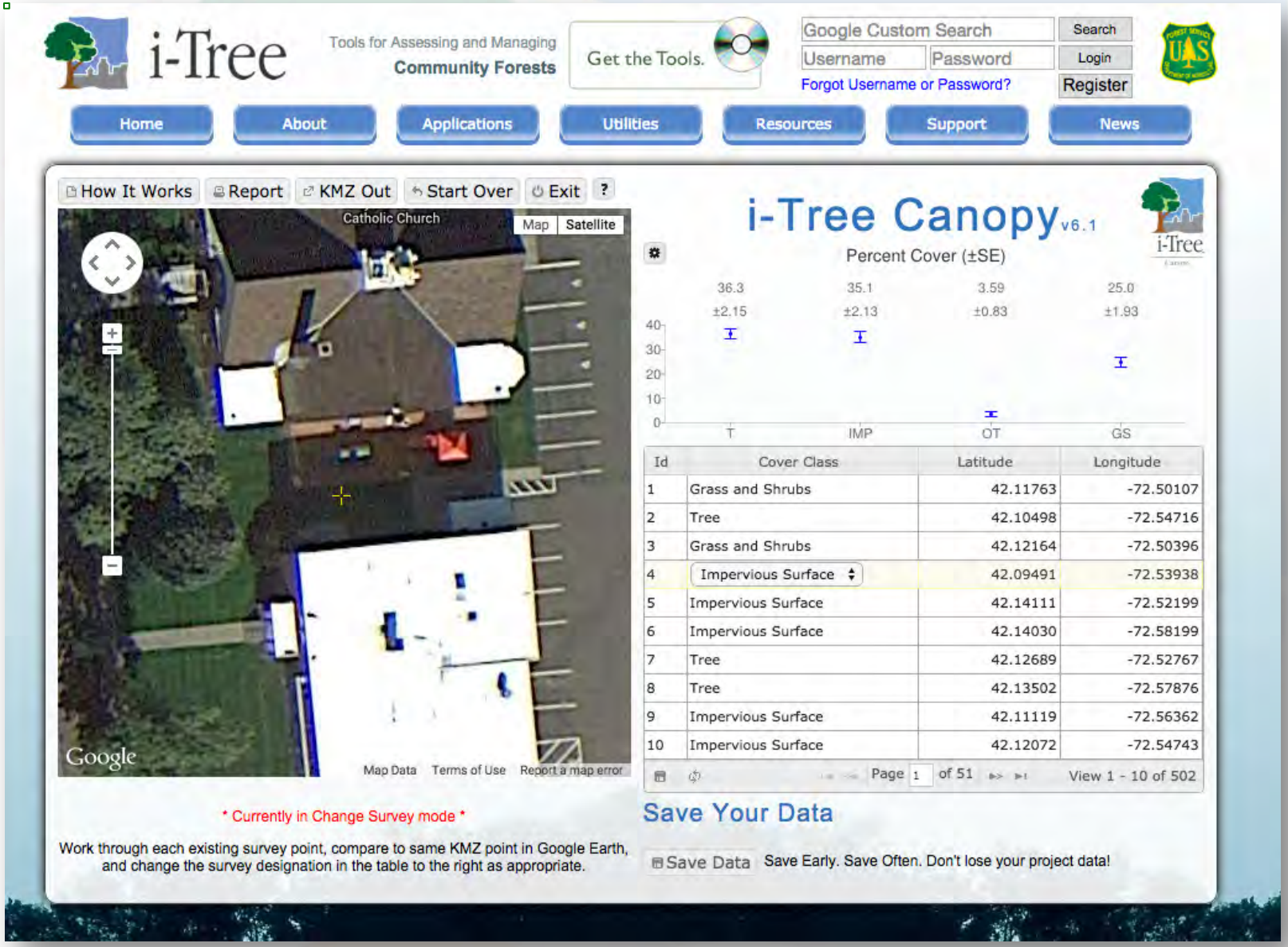
Worcester
Quincy
Springfield
Brockton
Tree Canopy Cover 36.7%
Tree Cover (sq. mi.) 11.8
Tree Canopy Cover Value
$ 22642220.86
Tree Canopy Cover 43.1%
Tree Cover (sq. mi.) 7.21
Tree Canopy Cover Value
$ 13837228.31
Fall River
New Bedford
Tree Canopy Cover 39.3%
Tree Cover (sq. mi.) 14.1
Tree Canopy Cover Value
$ 27026730.16
Tree Canopy Cover 45.9%
Tree Cover (sq. mi.) 9.88
Tree Canopy Cover Value
$ 18965875.33
Tree Canopy Cover 59.3%
Tree Cover (sq. mi.) 18.7
Tree Canopy Cover Value
$ 35983596.36
Tree Canopy Cover 32.8%
Tree Cover (sq. mi.) 6.58
Tree Canopy Cover Value
$ 12,623,87.04

Urban Tree Canopy (UTC)

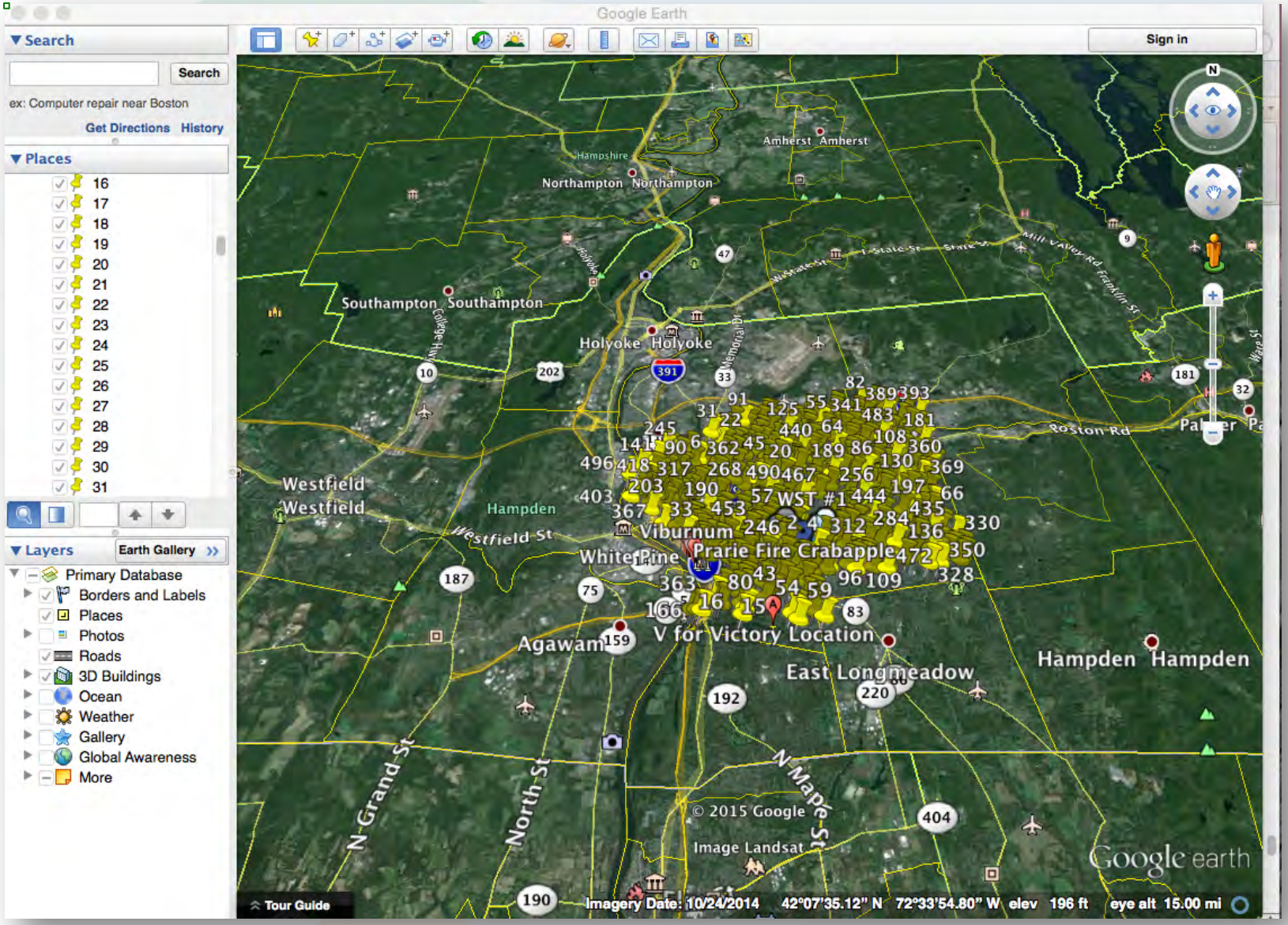
A Historical Analysis

i-Tree Canopy

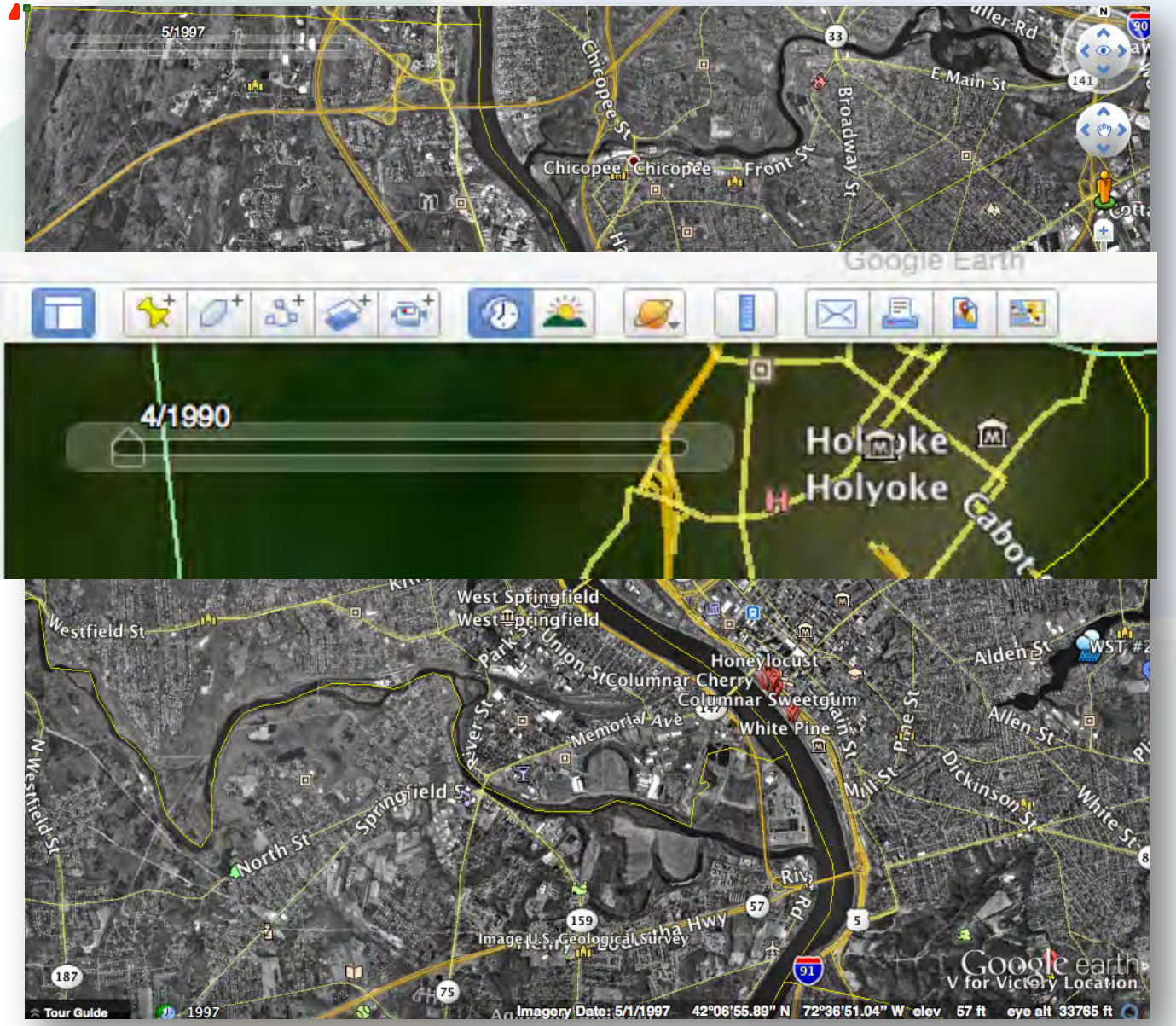


i-Tree Canopy: Change Survey

Google Earth



i-Tree Canopy: Timeline Photos




Historic Comparison


Historic Comparison

Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	60	12.0 ±1.45
Impervious Paved	Road, asphault, parking lots	Imp. Paved	104	20.8 ±1.82
Impervious Building	Houses, roofs, buildings	Imp. Build.	59	11.8 ±1.44
Pervious Surface	Grass, Brush, soil, dirt	Per. Sur.	259	51.8 ±2.23
Water	Water	H2O	18	3.60 ±0.83

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$96.40	±11.67	1.14 T	±0.14
NO2	Nitrogen Dioxide removed annually	$165.96	±20.10	6.20 T	±0.75
O3	Ozone removed annually	$8,642.84	±1,046.70	61.75 T	±7.48
PM2.5	Particulate Matter less than 2.5 microns removed annually	$17,866.33	±2,163.72	3.00 T	±0.36
SO2	Sulfur Dioxide removed annually	$29.01	±3.51	3.91 T	±0.47
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$6,274.48	±759.88	20.68 T	±2.50
CO2seq	Carbon Dioxide sequestered annually in trees	$239,463.43	±29,000.46	12,366.85 T	±1,497.70
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$7,263,706.50	±879,678.54	375,126.79 T	±45,430.11

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.902 @ $85.08 | NO2 4.917 @ $26.36 | O3 48.968 @ $140.47 | PM2.5 2.373 @ $5,975.67 | SO2 3.098 @ $7.45 | PM10 16.403 @ $304.43 | [illegible] amount of 297,489.961 @ $19.43*

Note: Standard errors of removal amounts and benefits were calculated based on standard [illegible]

2001

12.0%

Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	114	22.8 ±1.88
Impervious Paved	Road, asphault, parking lots	Imp. Paved	95	19.0 ±1.75
Impervious Building	Houses, roofs, buildings	Imp. Build.	61	12.2 ±1.46
Pervious Surface	Grass, Brush, soil, dirt	Per. Sur.	211	42.2 ±2.21
Water	Water	H2O	19	3.80 ±0.86

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$183.15	±15.07	2.16 T	±0.18
NO2	Nitrogen Dioxide removed annually	$315.32	±25.95	11.78 T	±0.97
O3	Ozone removed annually	$16,421.40	±1,351.35	117.32 T	±9.65
PM2.5	Particulate Matter less than 2.5 microns removed annually	$33,946.03	±2,793.48	5.70 T	±0.47
SO2	Sulfur Dioxide removed annually	$55.11	±4.54	7.42 T	±0.61
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$11,921.51	±981.04	39.30 T	±3.23
CO2seq	Carbon Dioxide sequestered annually in trees	$454,980.51	±37,441.14	23,497.01 T	±1,933.61
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$13,801,042.34	±1,135,711.73	712,740.89 T	±58,652.69

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.902 @ $85.08 | NO2 4.917 @ $26.36 | O3 48.968 @ $140.47 | PM2.5 2.373 @ $5,975.67 | SO2 3.098 @ $7.45 | PM10 16.403 @ $304.43 | CO2seq 9,807.385 @ $19.43 | CO2stor is a total biomass amount of 297,489.961 @ $19.43*

Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.

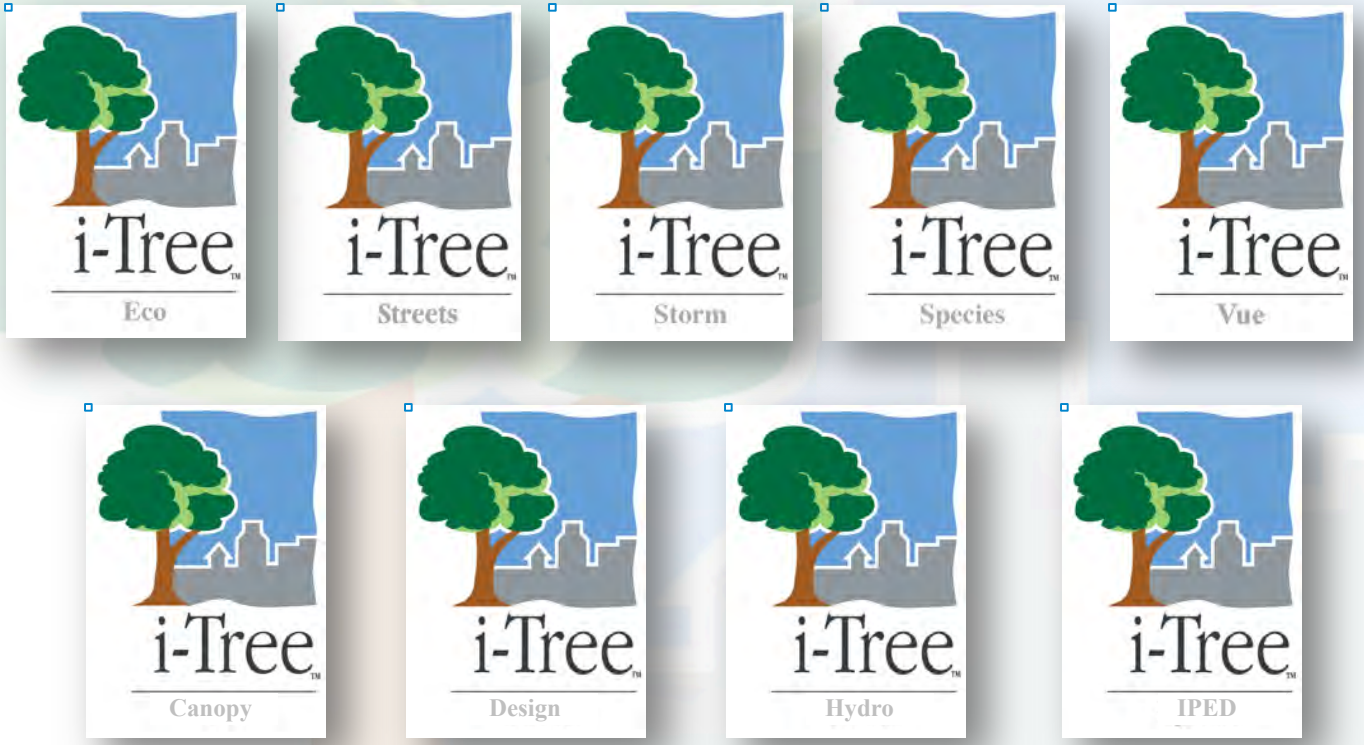
22.8%

2014

i-Tree 2015 Tools for Urban Forest Assessment

What is i-Tree?

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



Historic Trends

Using i-Tree to Examine Changes in a Community's Urban Forest

www.unri.org/research-documents

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