The Science Behind a Tree's Value:

Explained in plain English for the rest of us.

David Bloniarz
Northern Research Station
USDA Forest Service
Amherst, MA

Urban Forests & Tree Canopy

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Queens, NY

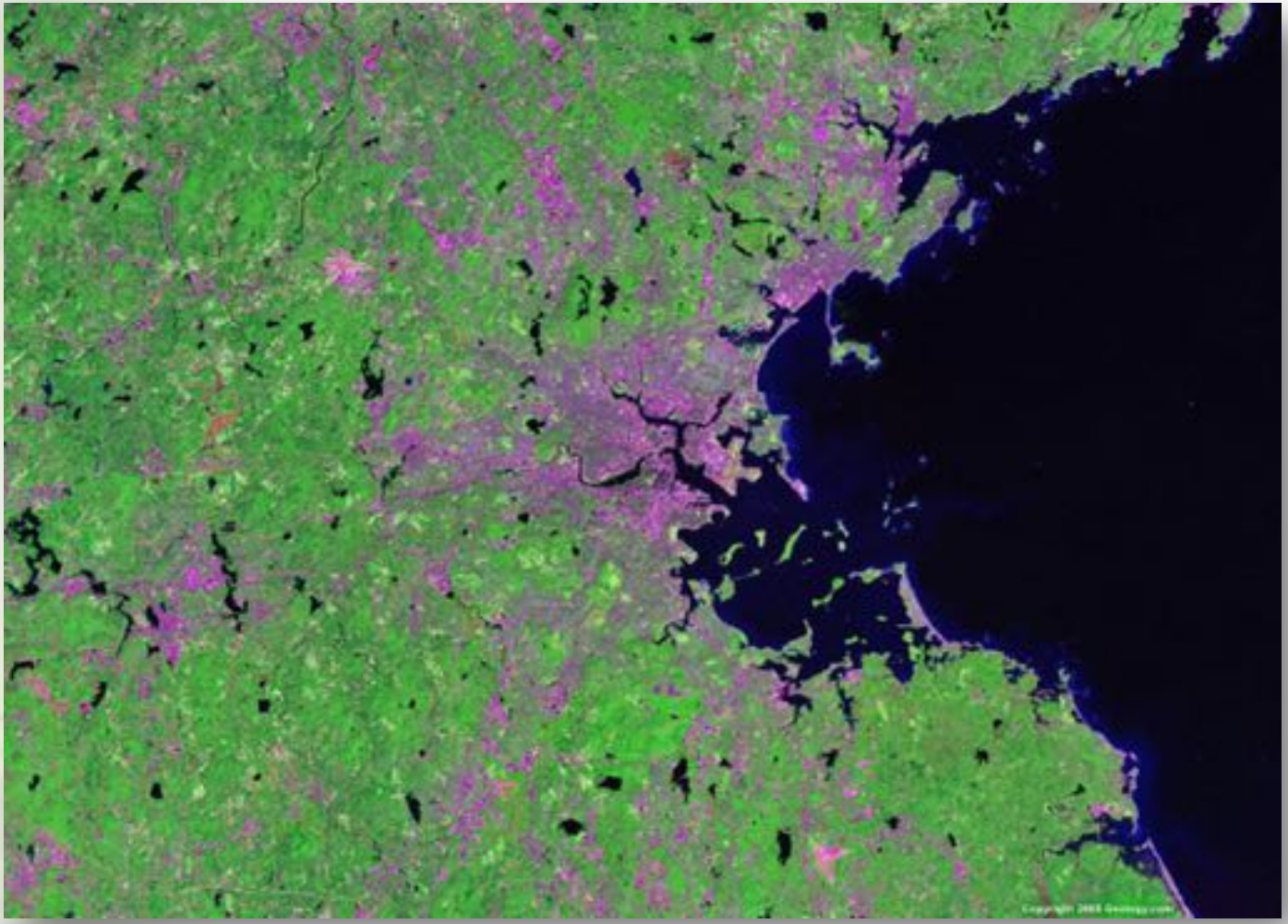
Urban Forests & Tree Canopy

Brooklyn, NY

Urban Forests & Tree Canopy

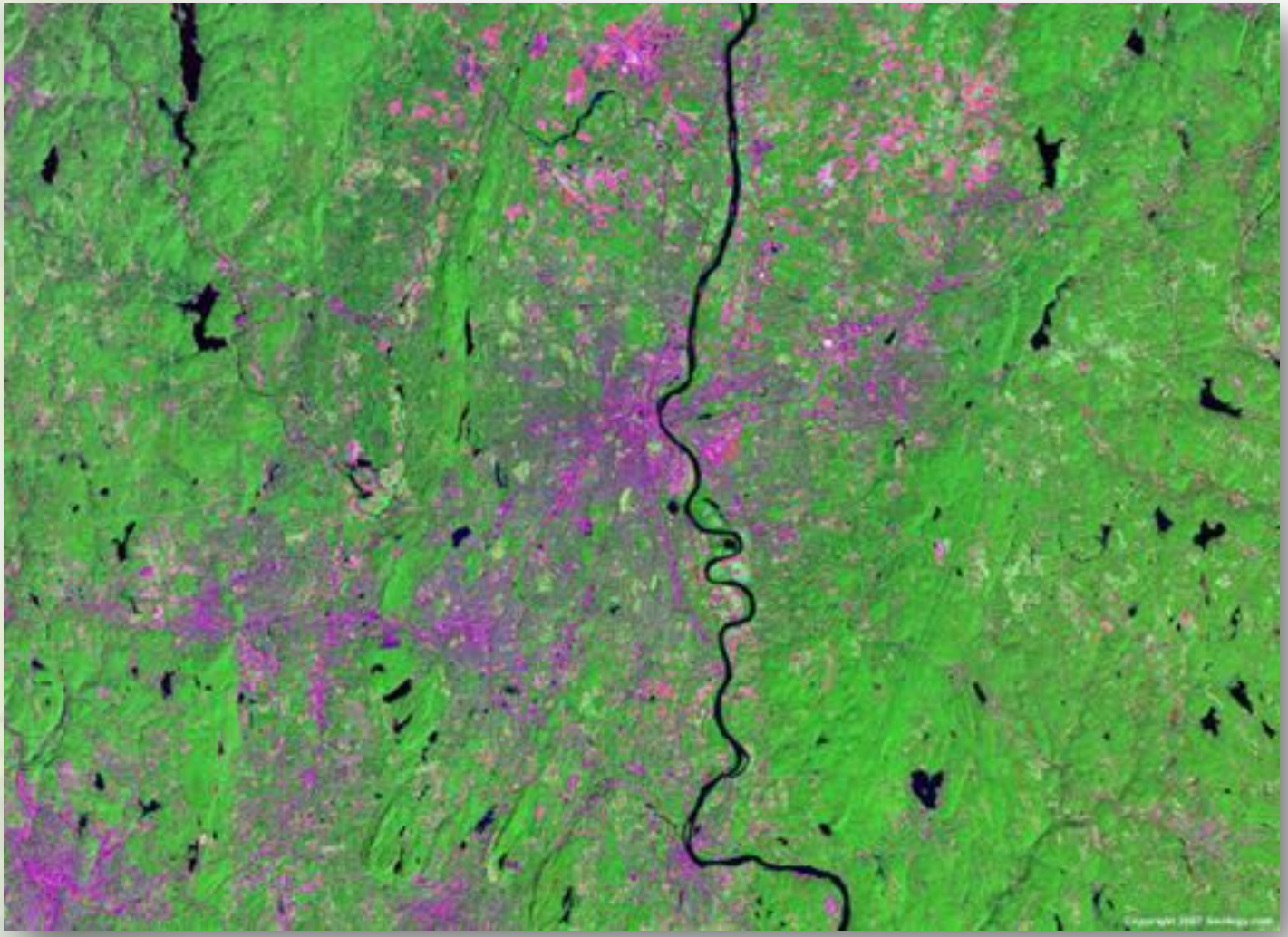
Chicago, IL

Urban Forests & Tree Canopy



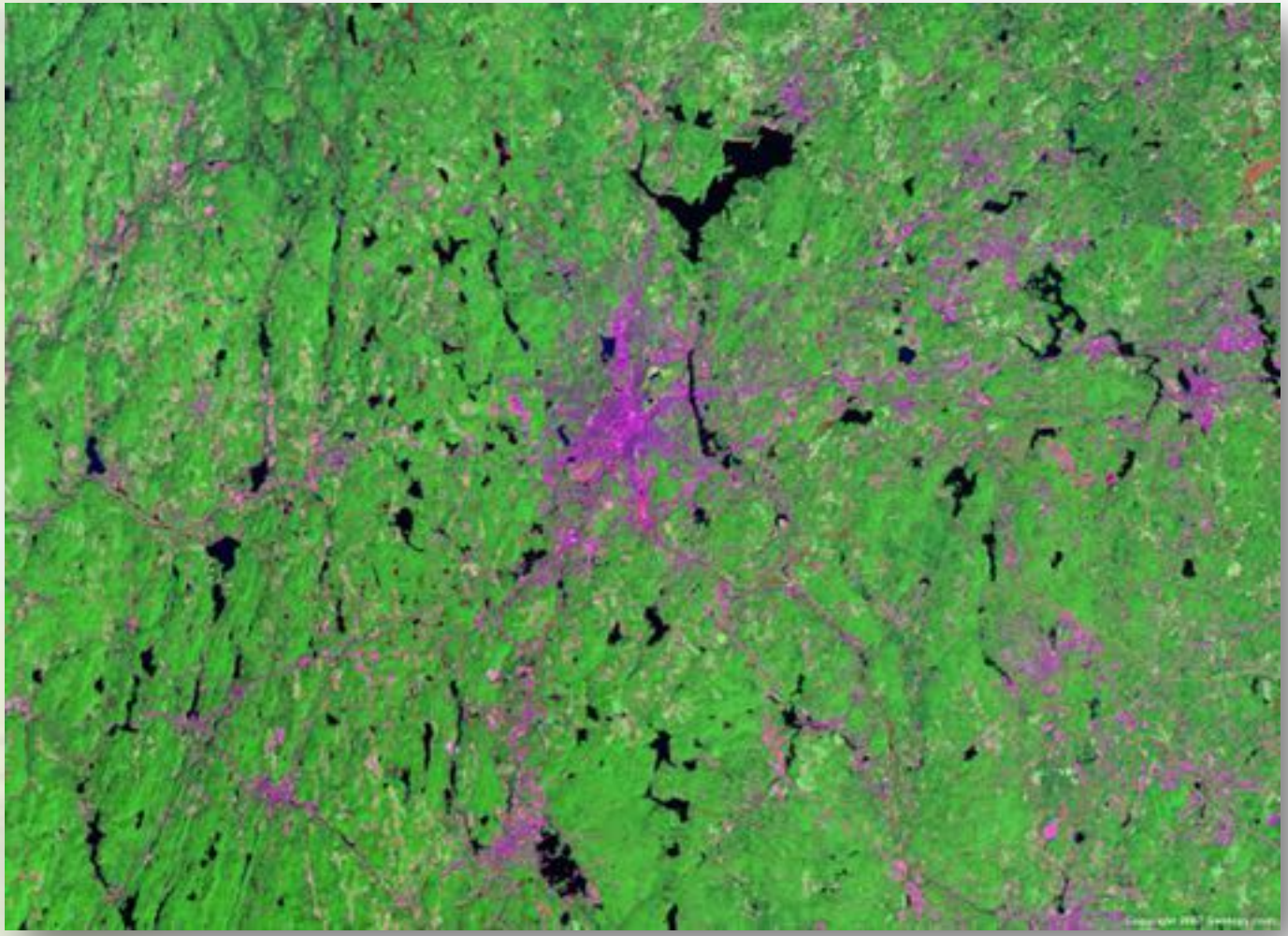
Boston, MA

Urban Forests & Tree Canopy



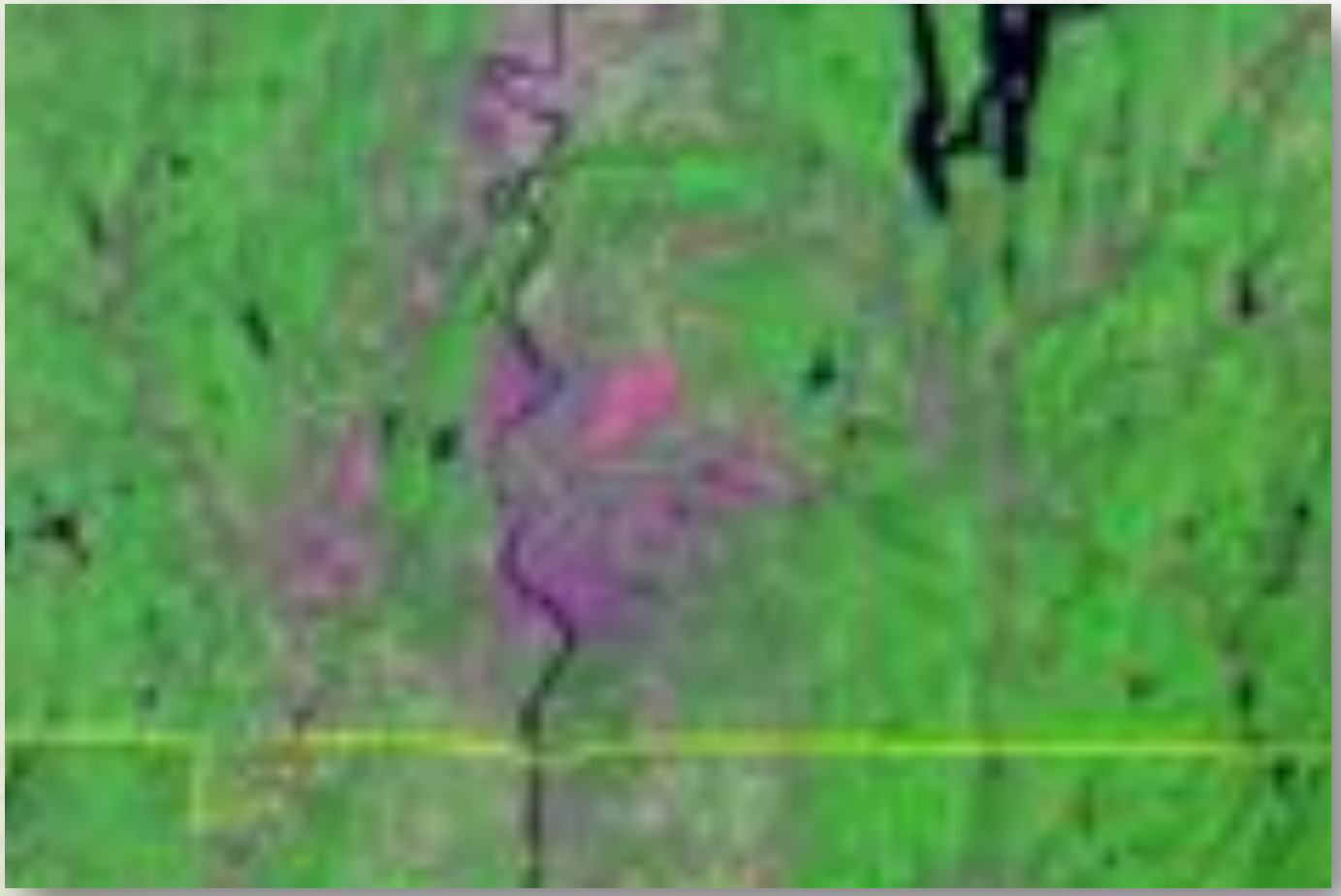
Hartford, CT

Urban Forests & Tree Canopy



Worcester, MA

Urban Forests & Tree Canopy



Springfield, MA

Urban Forests & Tree Canopy

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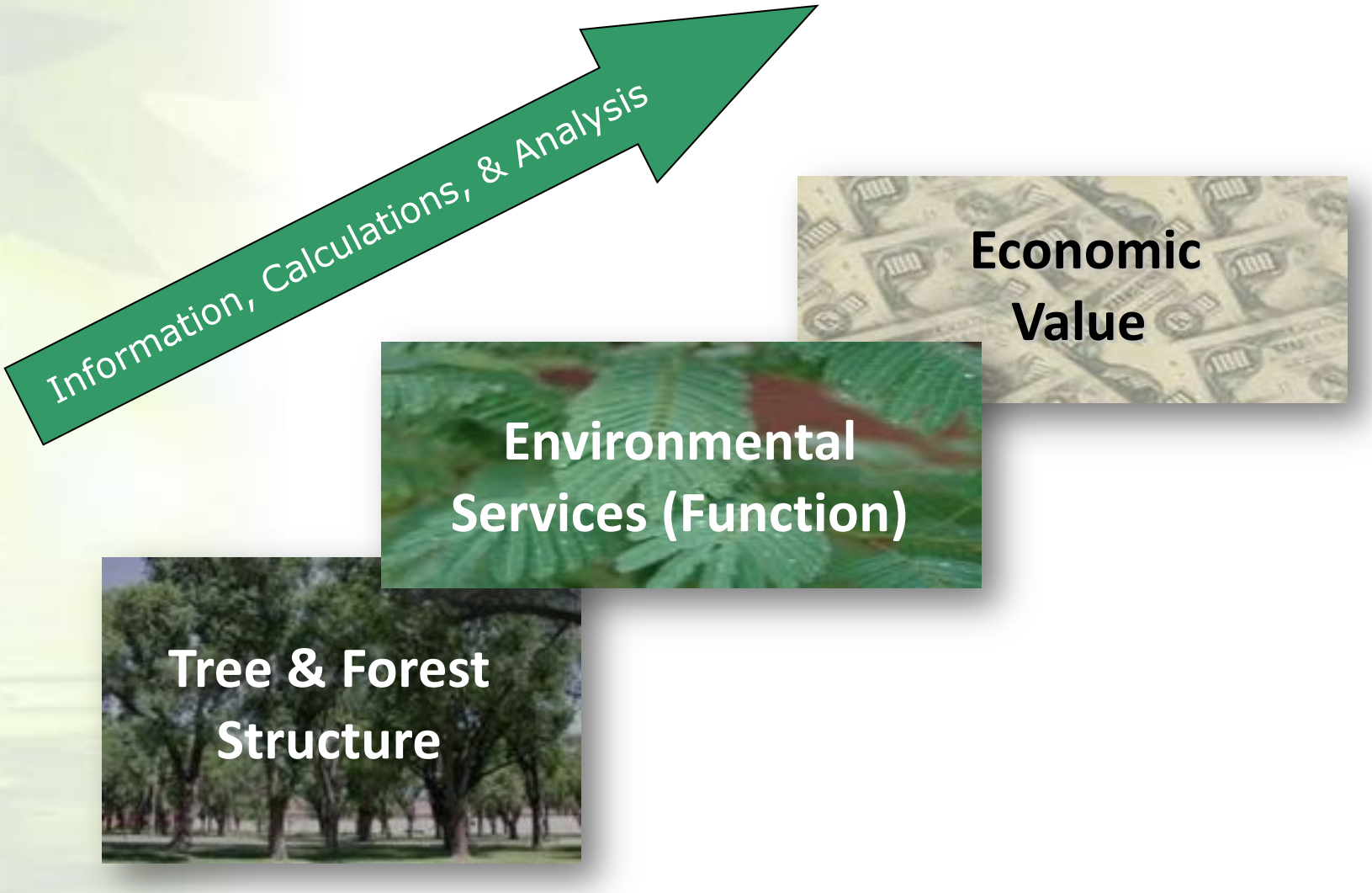
Establishing a Tree's Value



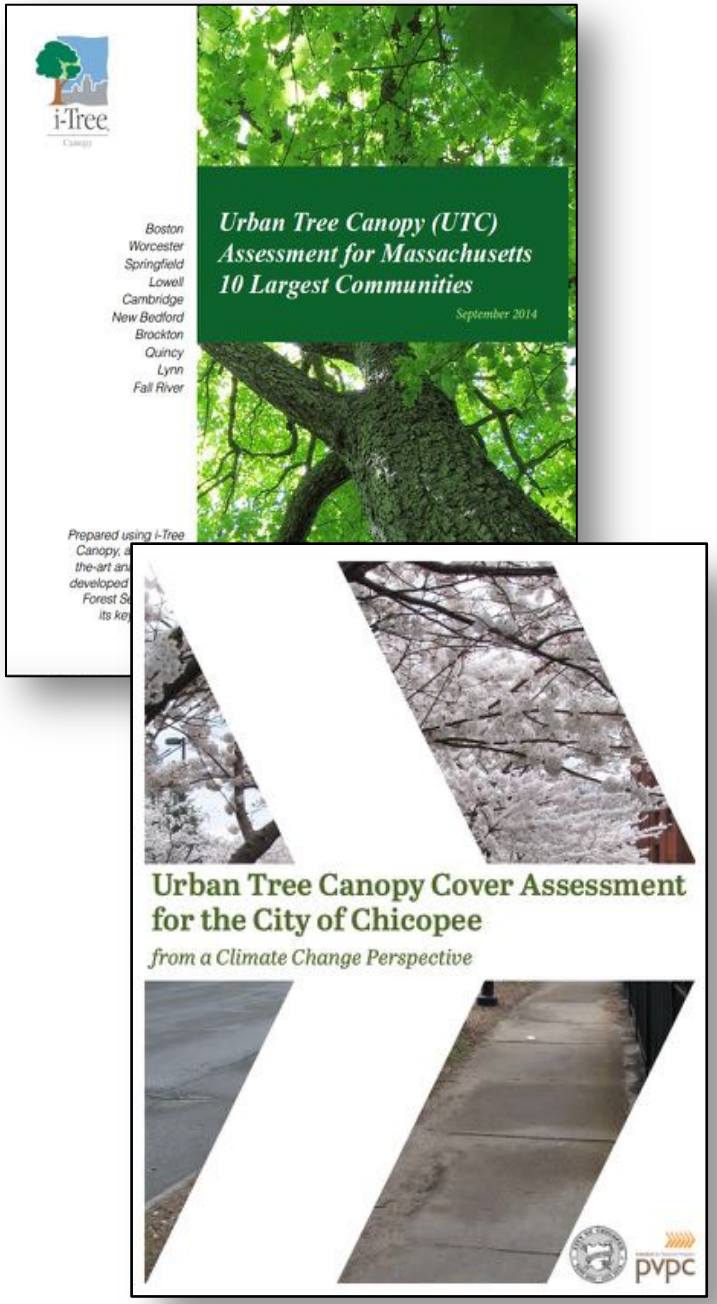
Structure ➡ Function ➡ Value

Concept applies to multiple scales and land types

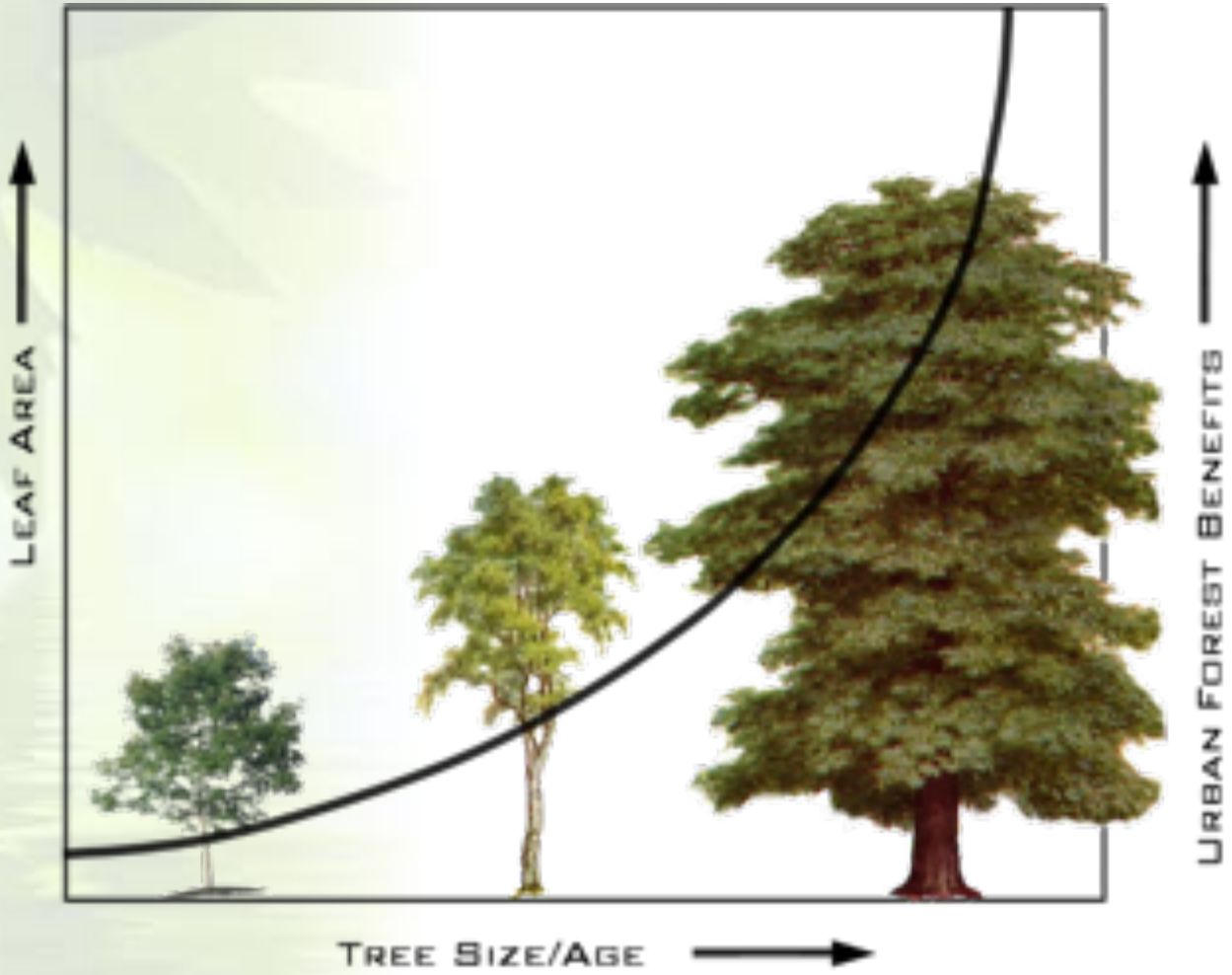
….home, park, corporate campus, neighborhood, city, region or watershed

Estimating Tree Benefits:

- Air pollution removal
- Carbon storage and annual carbon sequestration
- Avoided stormwater run-off *(hydrology effects)*
- Energy effects (*home cooling & heating*)
- Structural assessment
- $ Value for ecosystem services
- Public health impacts related to air quality



Tree species, size and leaf area area are key to calculating ecosystem services (benefits).



The Foundation: Local Data

- Local Sample or Inventory
- Local information:
  - Weather
  - Pollution
  - Environmental Variables
- Hourly simulations

Tree Benefit: Improve Air Quality

- Absorb pollutants through leaf surfaces
  - O_3 (ozone)
  - NO_2 (nitrogen dioxide)
  - SO_2 (sulfur dioxide)
- Intercept dust and/or particulate matter (PM10 and PM2.5)
- A reduction in energy production needs reduces creation of many air pollutants
- Release oxygen

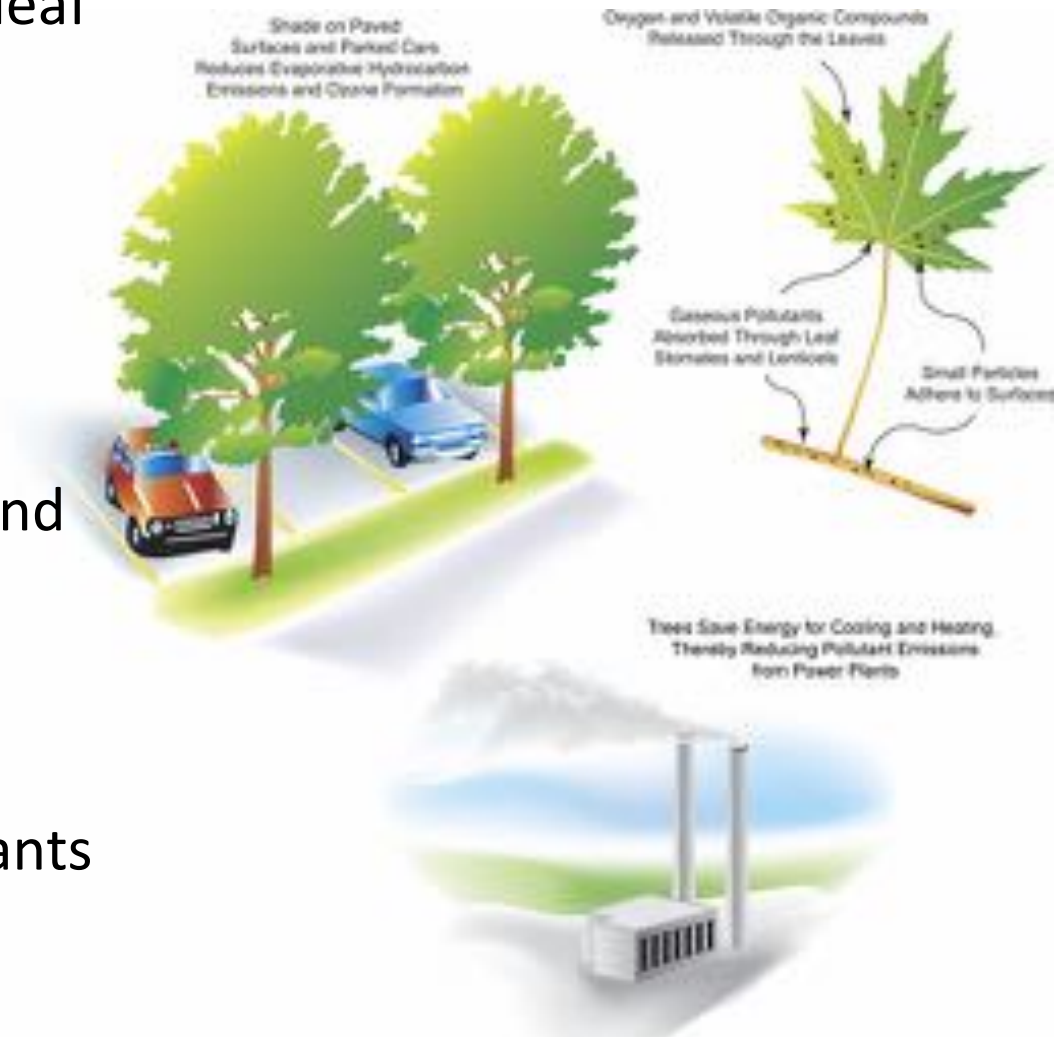
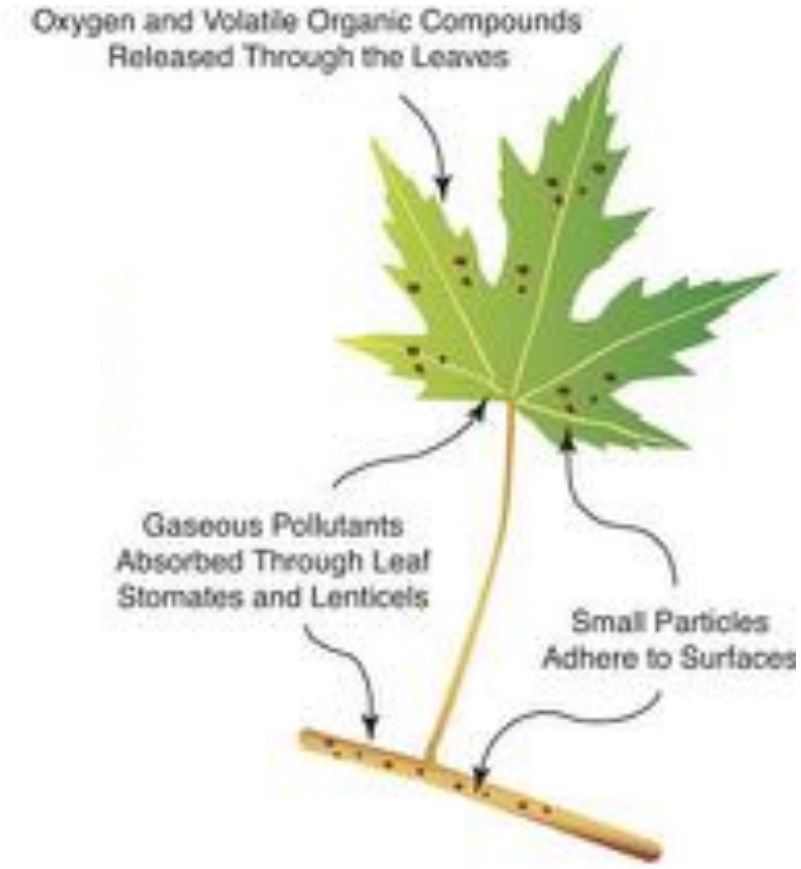


Image courtesy of the Center for Urban Forest Research

Improving Air Quality

- 15” Oak at 20 years (lbs):
  - NO_2 = 0.98
  - SO_2 = 2.72
  - PM_{10} = 0.52
  - Ozone = 0.84
  - VOCs = 0.21



USDA Forest Service, Springfield, MA i-Tree, 2019

Image courtesy of the Center for Urban Forest Research

Tree Benefit: Reduce Carbon Dioxide CO_2

- Trees are largely made of carbon so they take carbon out of the air and turn it into tissue (bark, leaves, wood, etc.)
- Tree can help reduce home energy needs, which also reduces additional carbon emissions released from power plants in the first place (*Secondary benefit*)

Image courtesy of the Center for Urban Forest Research

Reducing Atmospheric Carbon Dioxide

Image courtesy of the Center for Urban Forest Research

10" diameter deciduous shade trees

- 100 trees remove five tons of CO_2/year
- 100 trees remove about 1000 lbs of pollutants per year, including:
  - 400 lbs of ozone
  - 300 lbs of particulates

USDA Forest Service, Brattleboro, VT, i-Tree, 2020

Tree Benefit: Hydrology Effects

- Intercepts and holds rain on leaves, branches, and other surfaces
- Reduces stormwater runoff
- Increases water storage in soil
- Increase infiltration and helps recharge aquifers (underground water)
- Reduces erosion

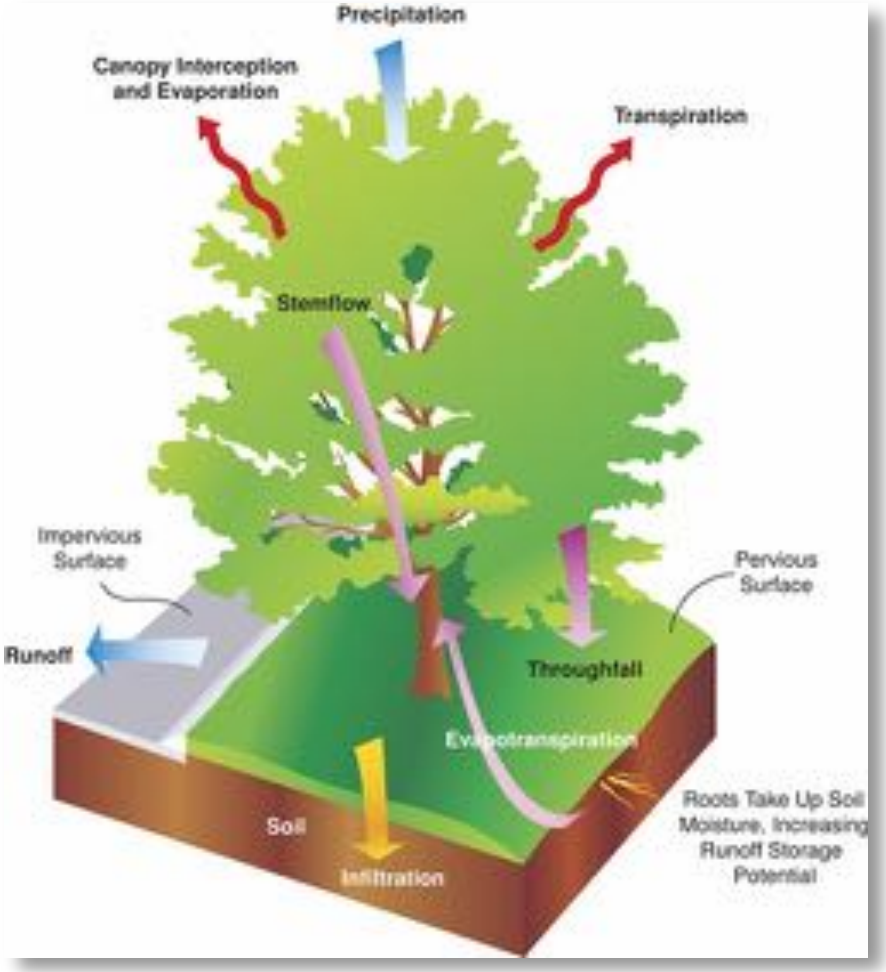


Image courtesy of the Center for Urban Forest Research

Trees & Energy – Summer Effects

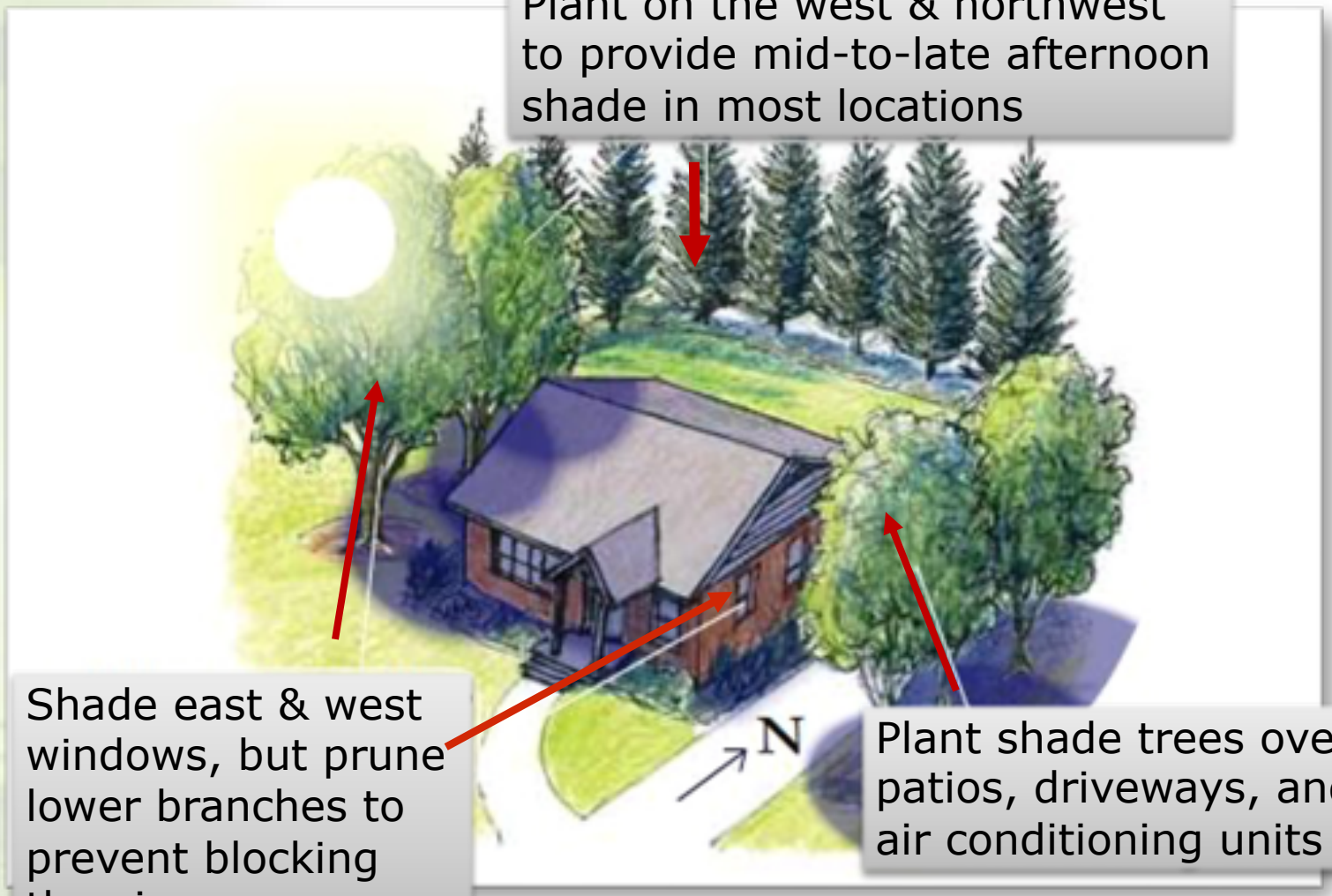


Image courtesy of Arbor Day Foundation
https://www.arborday.org/trees/

Trees & Energy – Winter Effects

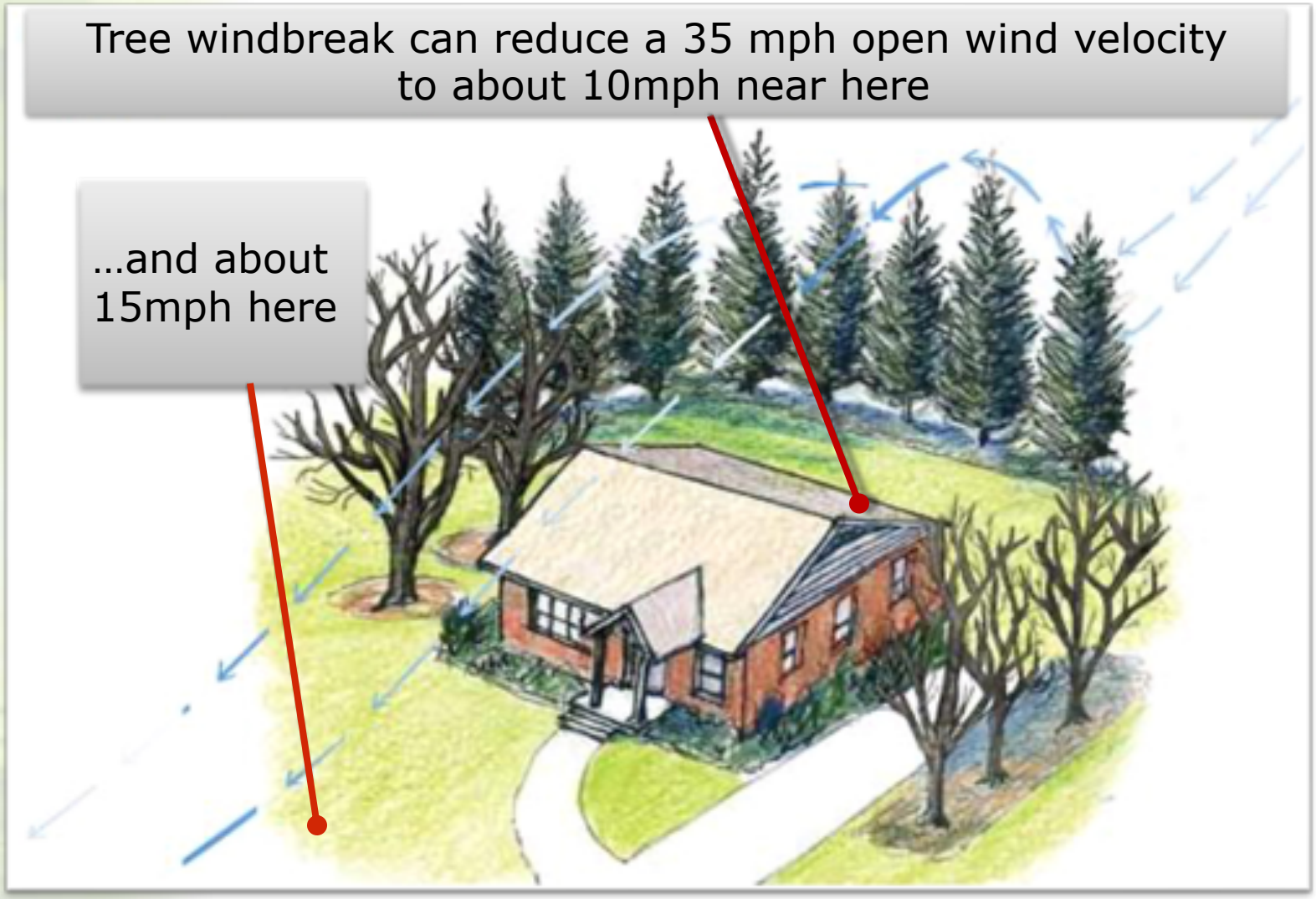
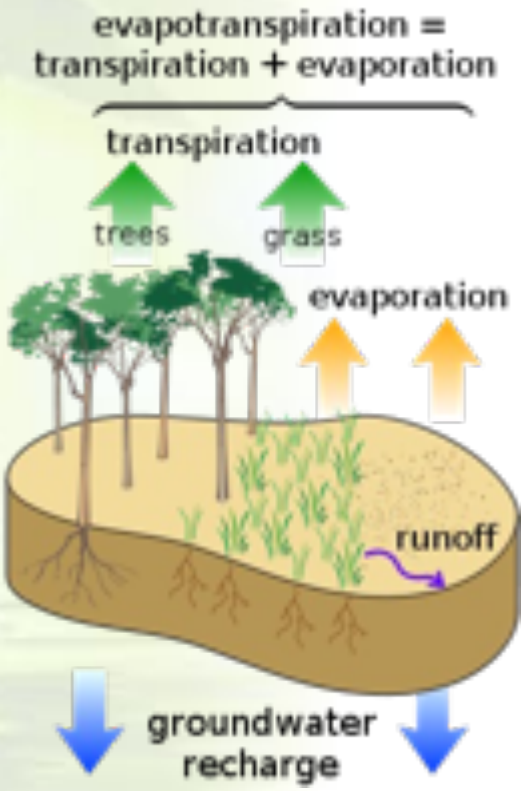


Image courtesy of Arbor Day Foundation
https://www.arborday.org/trees/

Trees & Energy – Combined Climate Effects

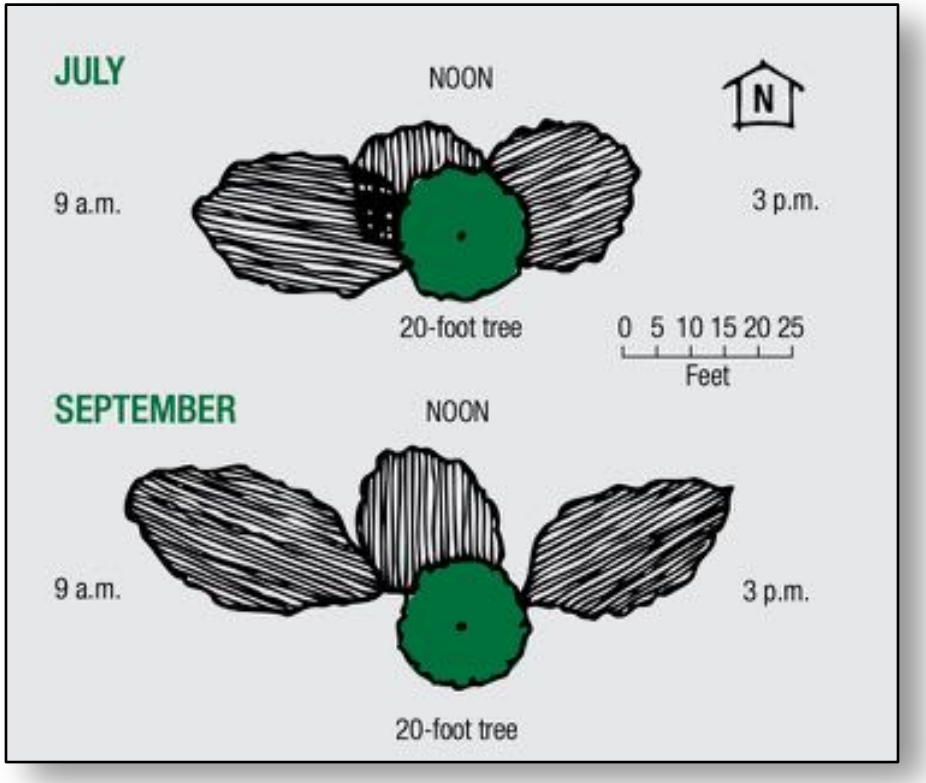
Combined effects of transpirational cooling along with shading of below canopy built surfaces can reduce air temps by as much as 9°F.



Source: Akbari et al.,1992. Cooling Our Communities: A Guide on Tree Planting and Light Colored Surfacing.

Trees & Energy – Indirect Effects

Reducing energy use at home lessens energy production demand – and associated emissions at power generation source



Tree City USA Bulletin No. 4, The Right Tree for the Right Place, National Arbor Day Foundation

Tree Benefit: Energy Effects Summary

- Trees shade buildings and built surfaces (summer)
- Act as a wind break reducing heat loss when cold (winter)

- Trees cool the air – (climate effect)
- Reduce energy demand at power generation source (*Secondary benefit*)

Image courtesy of the Center for Urban Forest Research

Conserving Energy

Northeast U.S. Average

- Save up to 30% of annual air conditioning costs

- Save 10-25% of winter heating costs

USDA Forest Service, i-Tree, 2021

Image courtesy of the Center for Urban Forest Research

Research Science and Data Development

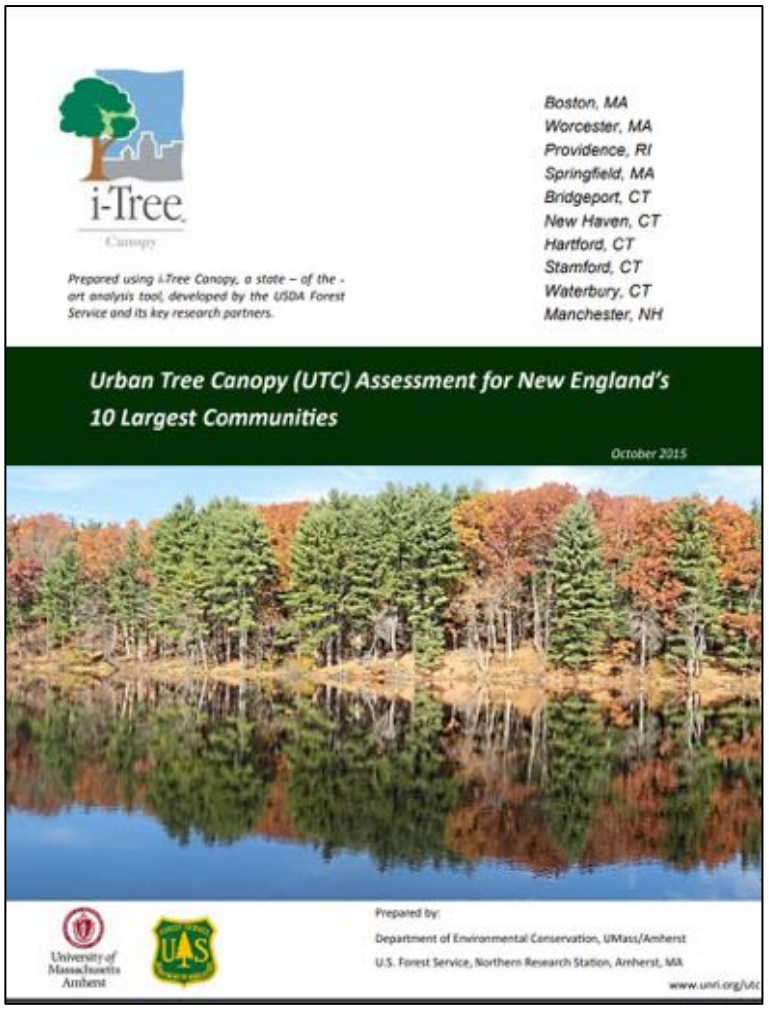
University Researchers

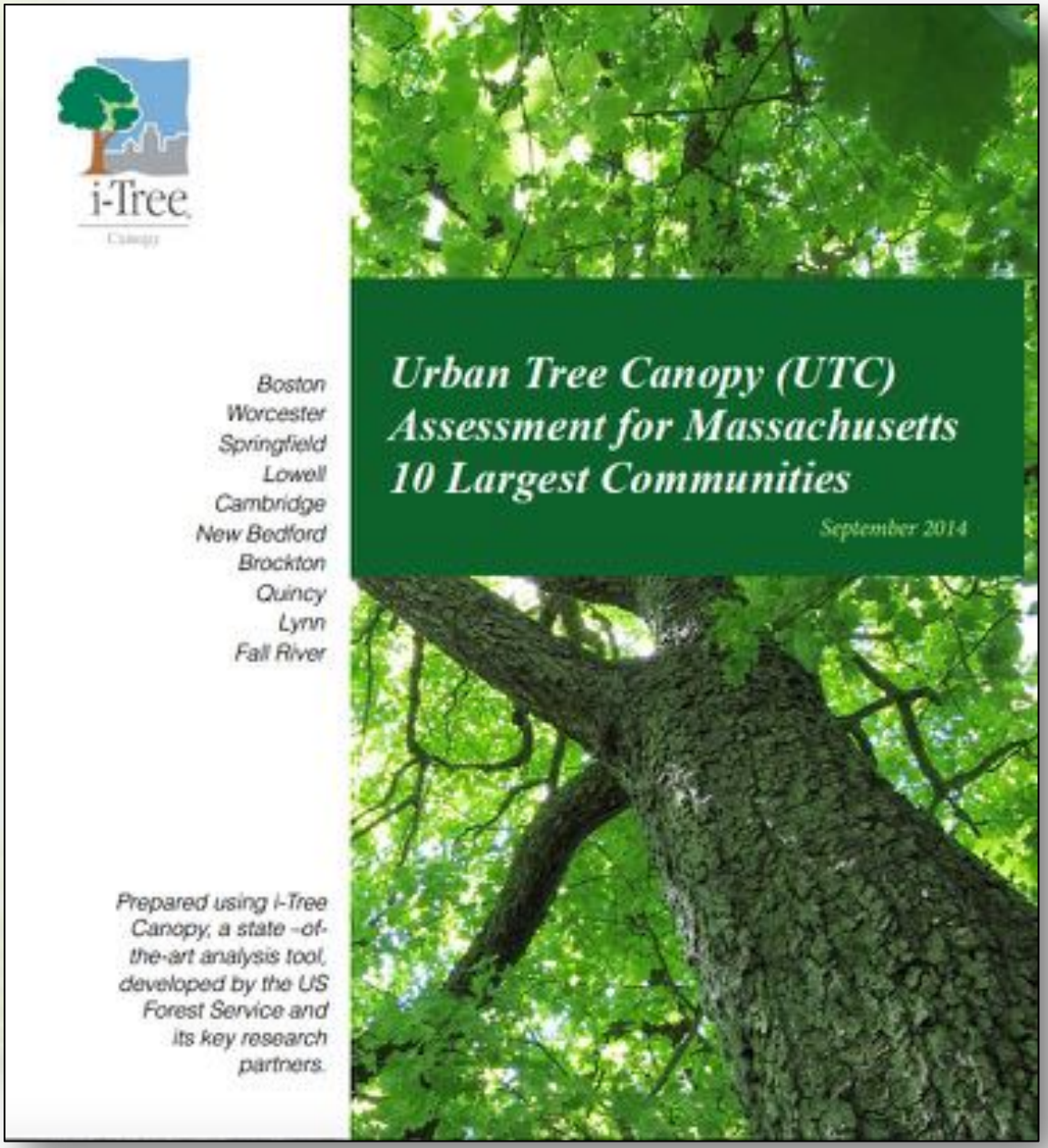
Citizen Scientists

Commercial Practitioners

Benefit-Based Approach

Using quantitative data to tell your story?

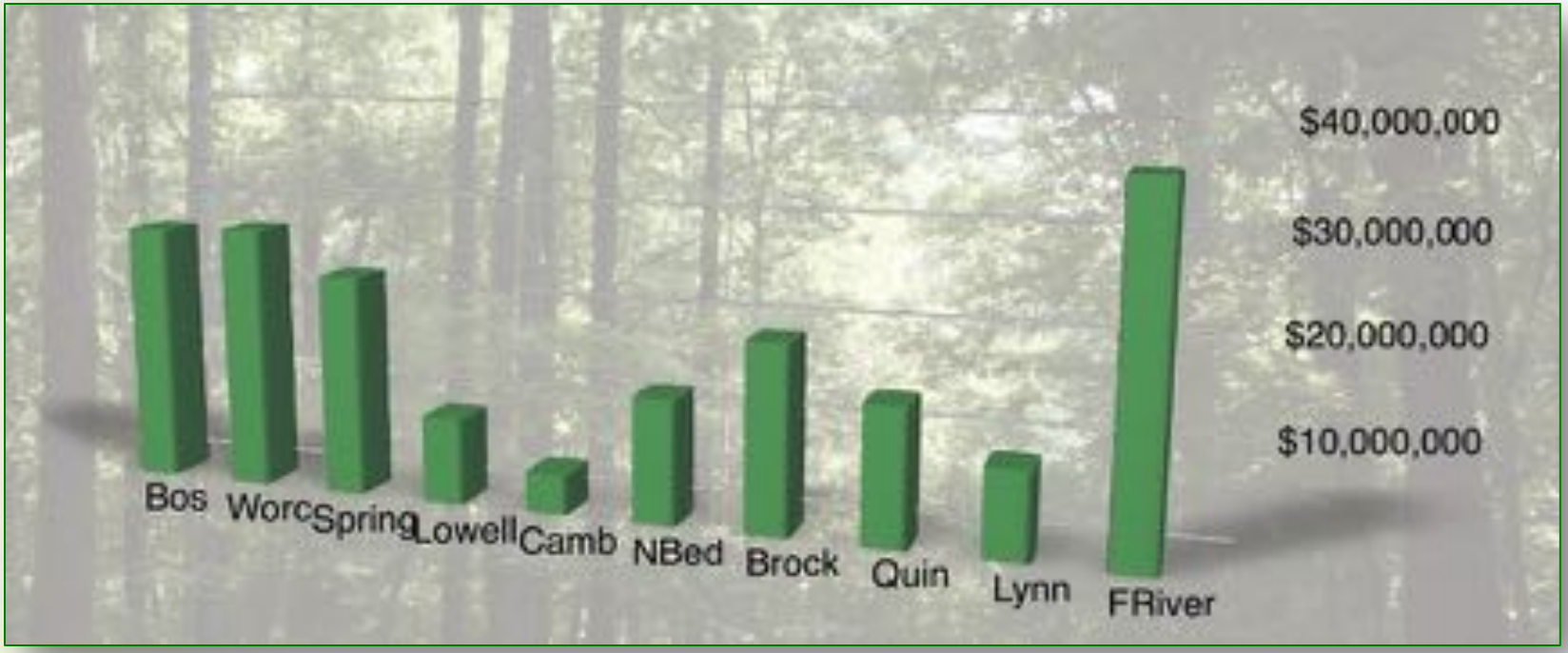



i-Tree
Canopy
Urban Tree Canopy (UTC) Assessment for Massachusetts 10 Largest Communities
September 2014
Boston
Worcester
Springfield
Lowell
Cambridge
New Bedford
Brockton
Quincy
Lynn
Fall River
Prepared using i-Tree Canopy, a state -of-the-art analysis tool, developed by the US Forest Service and its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

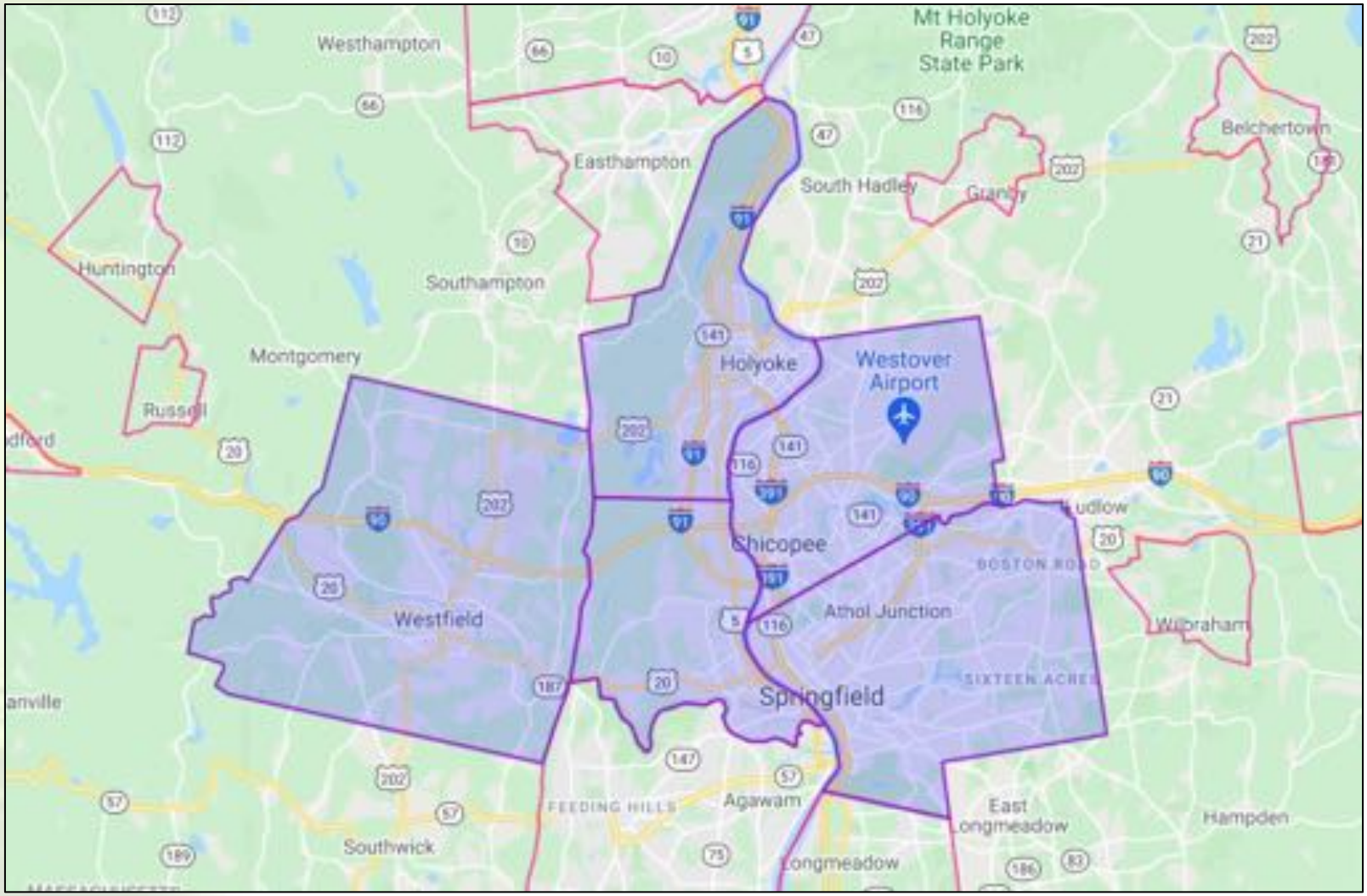

Massachusetts Ten Largest Communities by Population


Tree Canopy Cover 34%
Tree Cover (sq. mi.) 2.08
Tree Canopy Cover Value
$ 3984187.61
Tree Canopy Cover 31%
Tree Cover (sq. mi.) 4.59
Tree Canopy Cover Value
$ 8808326.99
Tree Canopy Cover 40.5%
Tree Cover (sq. mi.) 4.58
Tree Canopy Cover Value
$ 8790730.11
Lowell
Lynn
Cambridge
Boston
Tree Canopy Cover 27.9%
Tree Cover (sq. mi.) 13.9
Tree Canopy Cover Value
$ 26,587,698.27
Worcester
Quincy
Springfield
Brockton
Tree Canopy Cover 36.7%
Tree Cover (sq. mi.) 11.8
Tree Canopy Cover Value
$ 22642220.86
Tree Canopy Cover 41.1%
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
$ 18965075.33
Tree Canopy Cover 59.3%
Tree Cover (sq. mi.) 18.7
Tree Canopy Cover Value
$ 35903356.36
Tree Canopy Cover 32.8%
Tree Cover (sq. mi.) 6.58
Tree Canopy Cover Value
$ 12,623,87.04

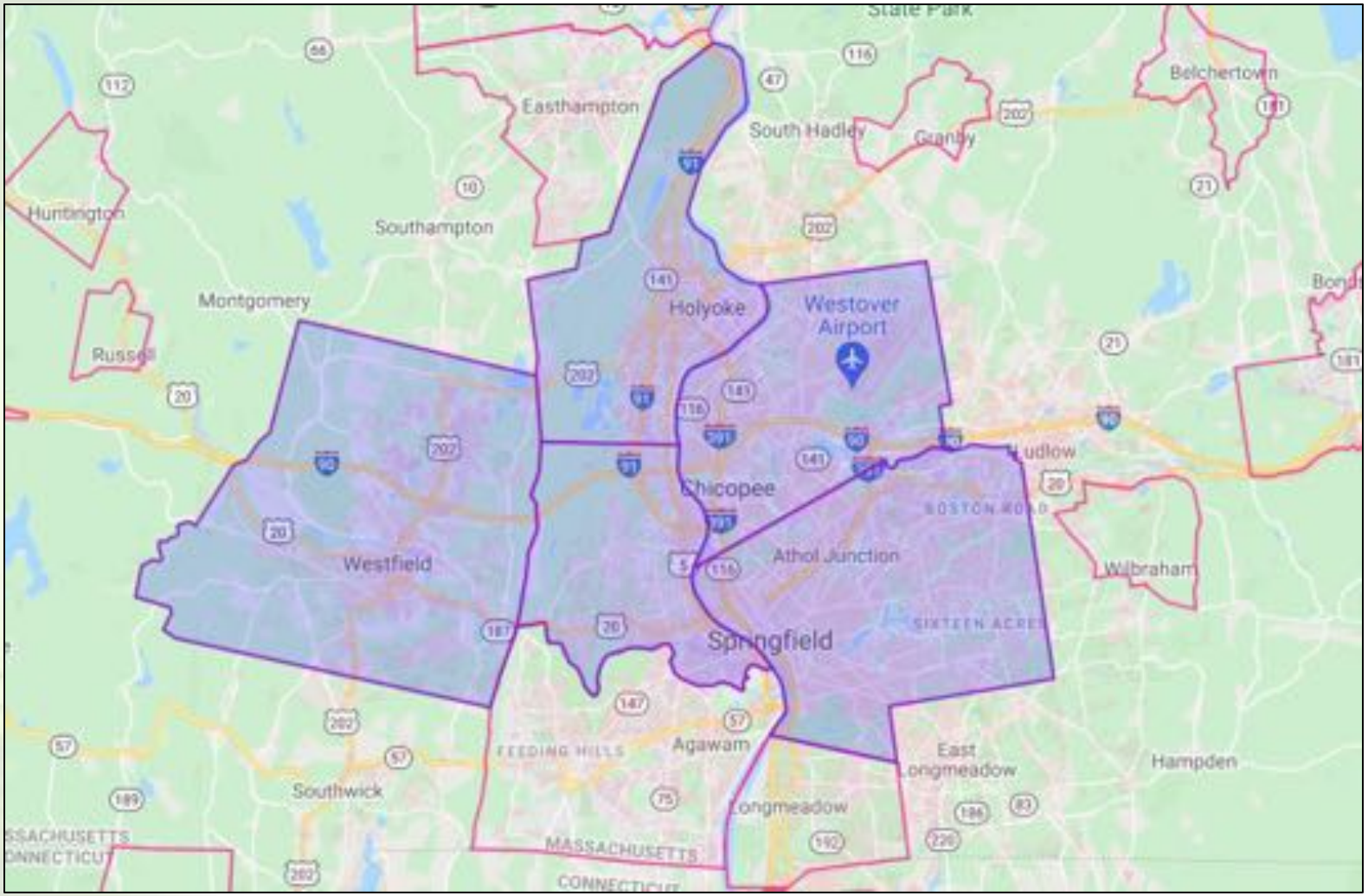
City Size Rank	City	% Canopy Cover	Report by Area (mi
1	Boston	27.9	13.9
2	Worcester	39.3	14.1
3	Springfield	36.7	11.8
4	Lowell	31	4.59
5	Cambridge	34	2.08
6	New Bedford	32.8	6.58
7	Brockton	45.9	9.88
8	Quincy	43.1	7.21
9	Lynn	40.5	4.58
10	Fall River	59.3	18.7


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

Forest Cover in Metro Springfield



Impervious Surfaces in Metro Springfield



Regreen Springfield in partnership with the US Forest Service:

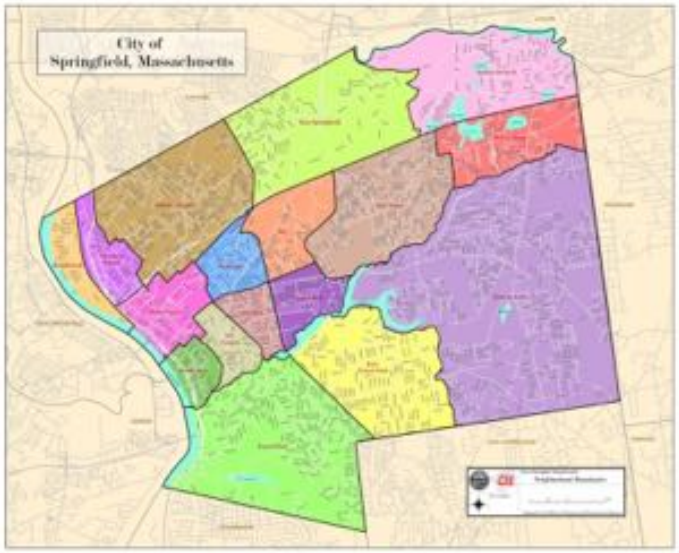
iTree Canopy Assessment

of Springfield Neighborhoods

August 2014

i-Tree

i-Tree Canopy

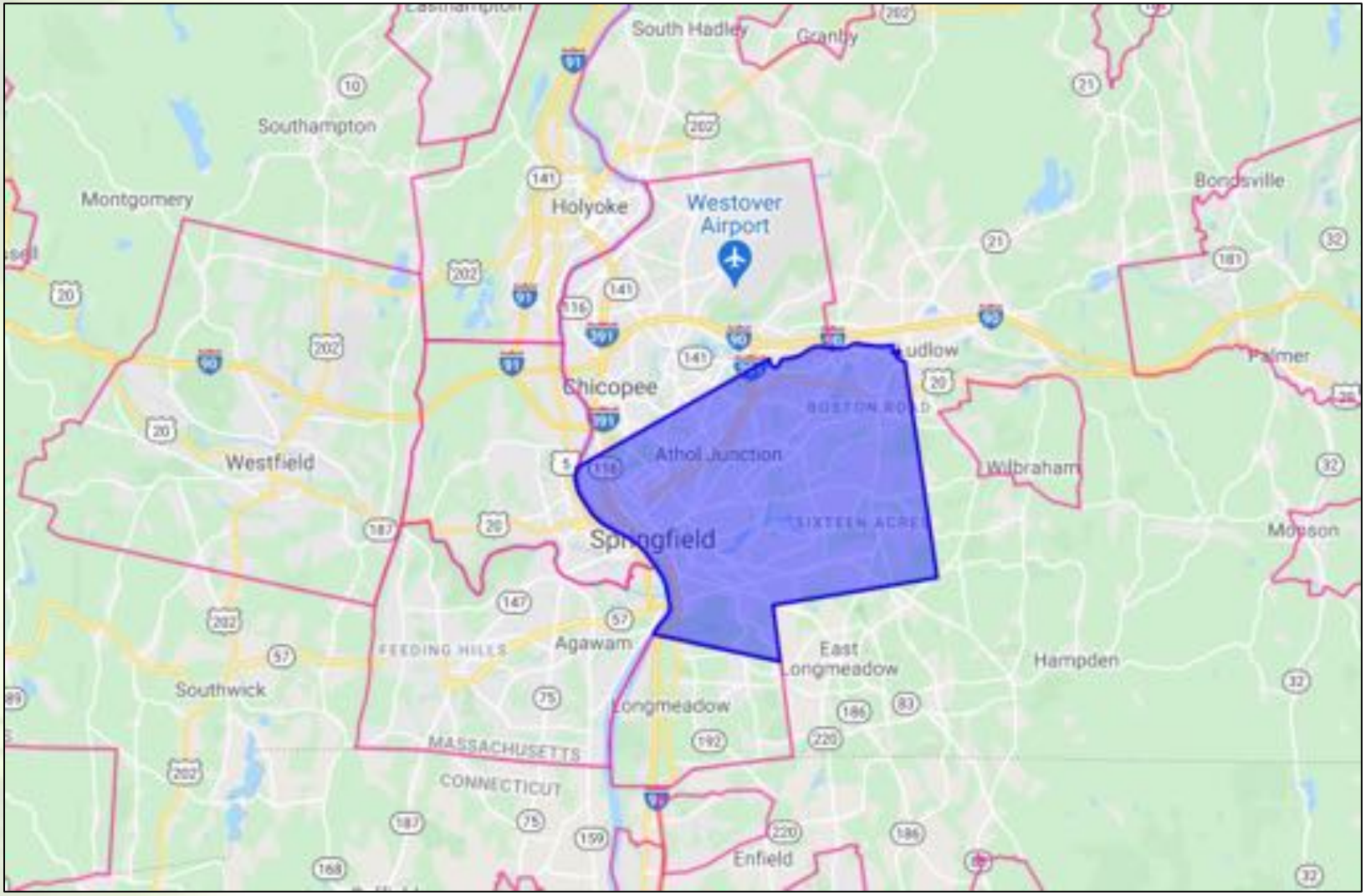


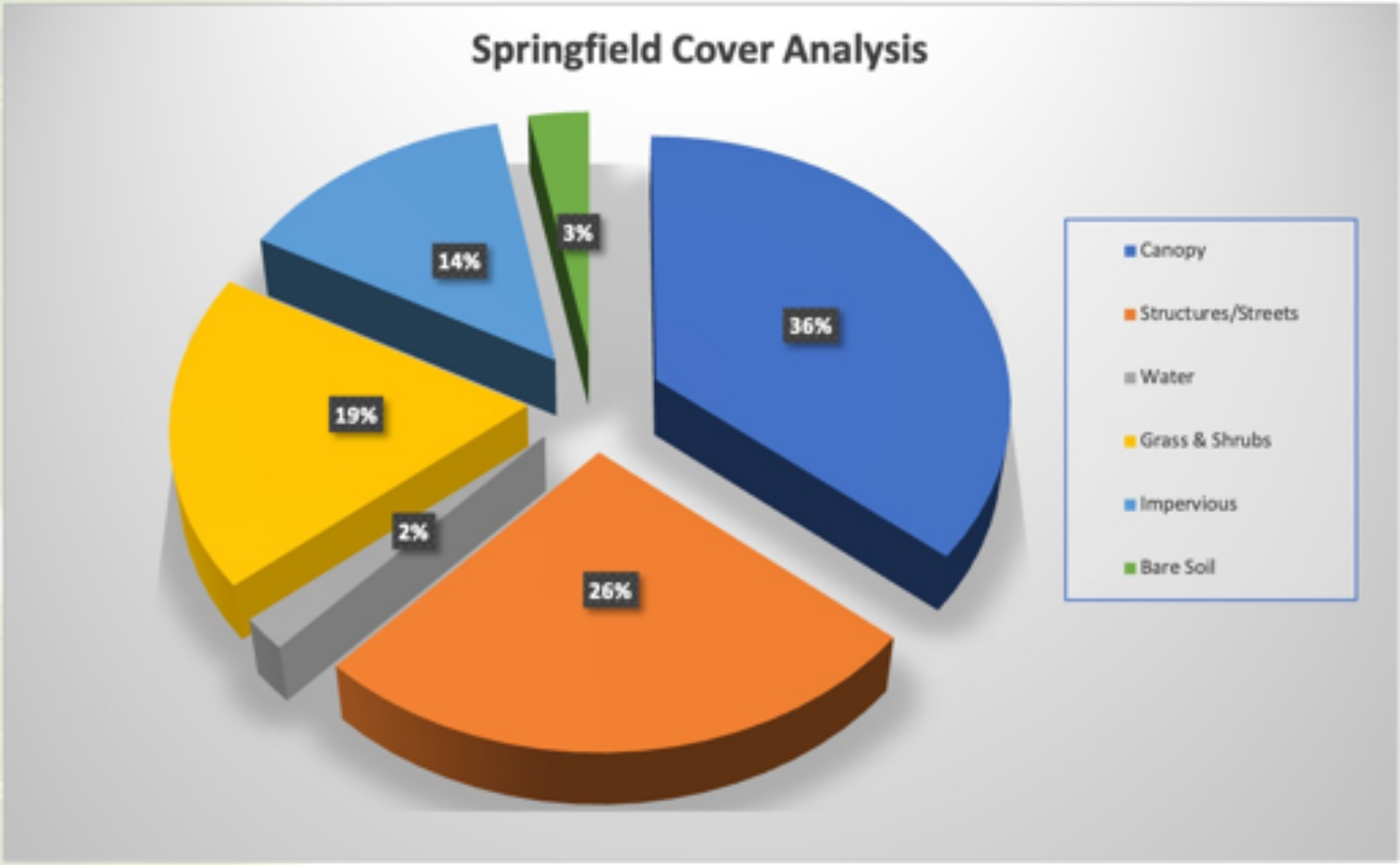
Springfield Report

March 2021

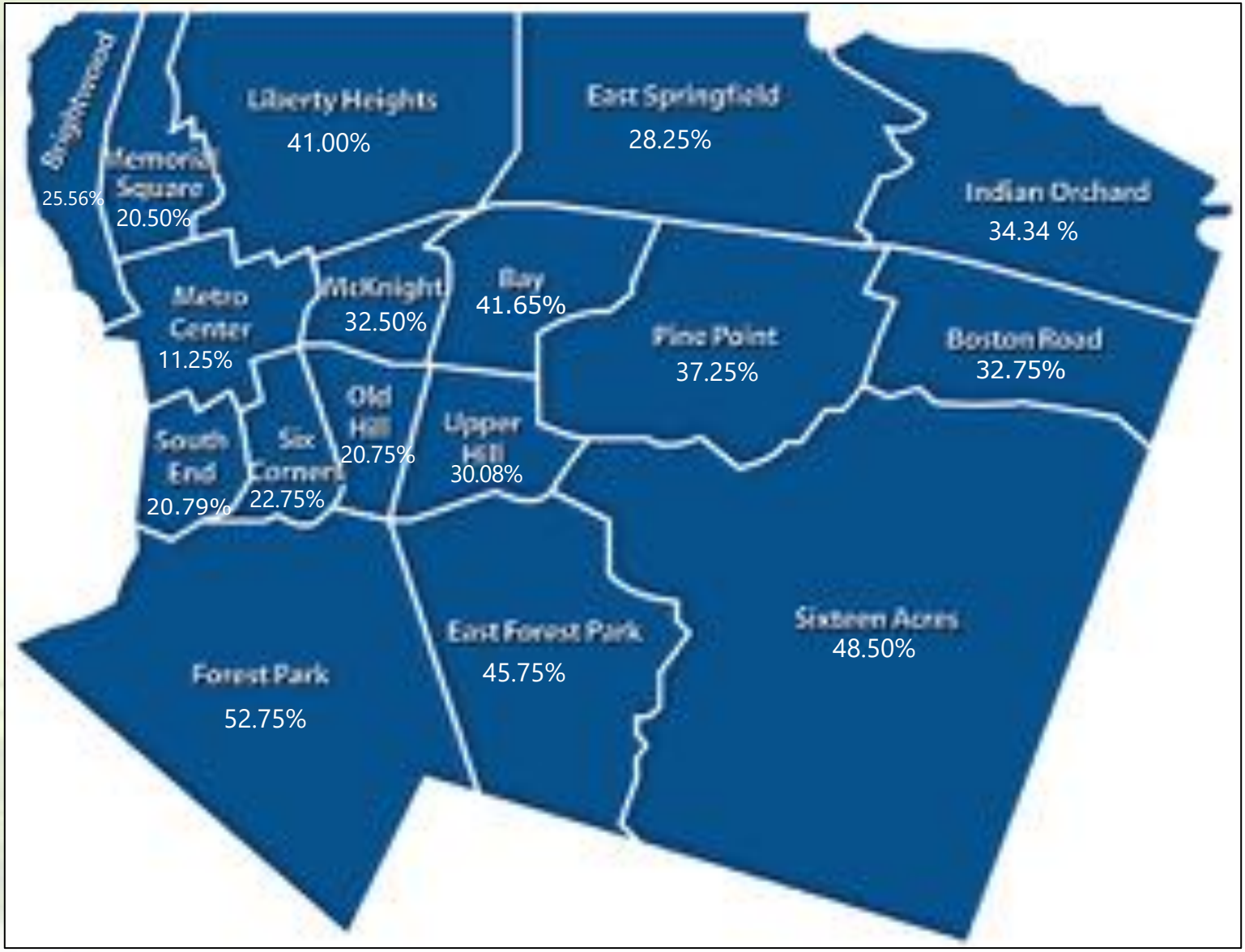
ReGreenSpringfield

USDA

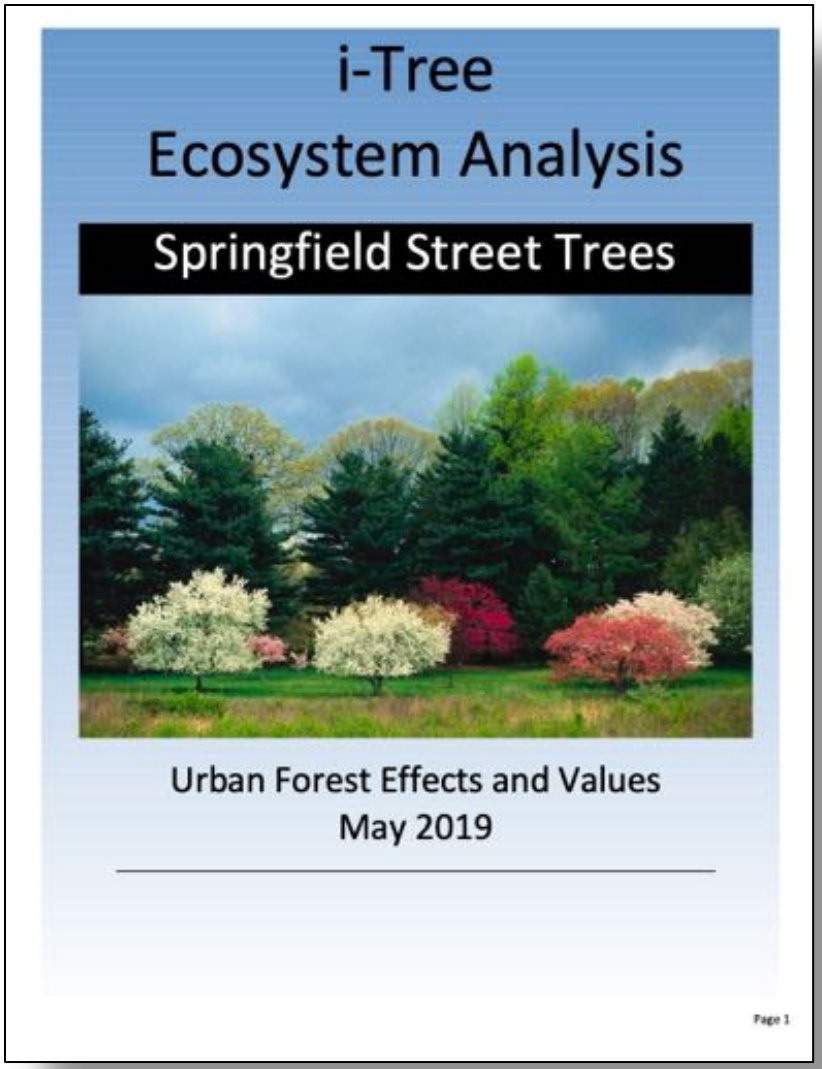

South Hadley
Granby
Southampton
Montgomery
Holyoke
Westover Airport
Bondsville
Chicopee
Ludlow
Palmer
Westfield
Athol Junction
Wilbraham
Springfield
Monson
Agawam
East Longmeadow
Hampden
Southwick
Longmeadow
MASSACHUSETTS
CONNECTICUT
Enfield


Springfield Cover Analysis
36%
26%
2%
19%
14%
3%
Canopy
Structures/Streets
Water
Grass & Shrubs
Impervious
Bare Soil

Springfield Tree Cover by Neighborhood



Springfield Street Tree Analysis



Springfield Street Tree Analysis

Table 2. The top 20 oxygen production species.

Species	*Oxygen (ton)*	*Gross Carbon Sequestration (ton/yr)*	*Number of Trees*	*Leaf Area (acre)*
Sugar maple	146.47	54.92	2,873	254.52
Norway maple	137.11	51.42	5,184	417.96
Northern red oak	112.07	42.03	1,699	179.00
Pin oak	105.52	39.57	1,656	129.05
Red maple	55.03	20.64	1,512	109.41
Silver maple	52.64	19.74	1,139	140.49
Scarlet oak	51.77	19.41	612	70.34
London planetree	34.15	12.81	955	107.54
White oak	32.67	12.25	449	41.29
Littleleaf linden	20.78	7.79	1,205	70.88
Honeylocust	18.85	7.07	588	17.09
Northern hackberry	13.65	5.12	355	27.42
Callery pear	9.69	3.63	714	13.17
American elm	7.27	2.73	367	22.01
American basswood	6.72	2.52	264	23.94
Black locust	5.92	2.22	179	9.35
apple spp	5.82	2.18	583	10.29
Eastern white pine	5.37	2.01	243	14.94
Norway spruce	5.29	1.98	184	19.92
White ash	4.47	1.68	204	8.51

Springfield Street Tree Analysis

Air Quality Health Impacts and Values by Trees

Location: Springfield, Hampden, Massachusetts, United States of America
Project: Springfield Street Trees, Series: Street Trees, Year: 2017
Generated: 5/8/2019

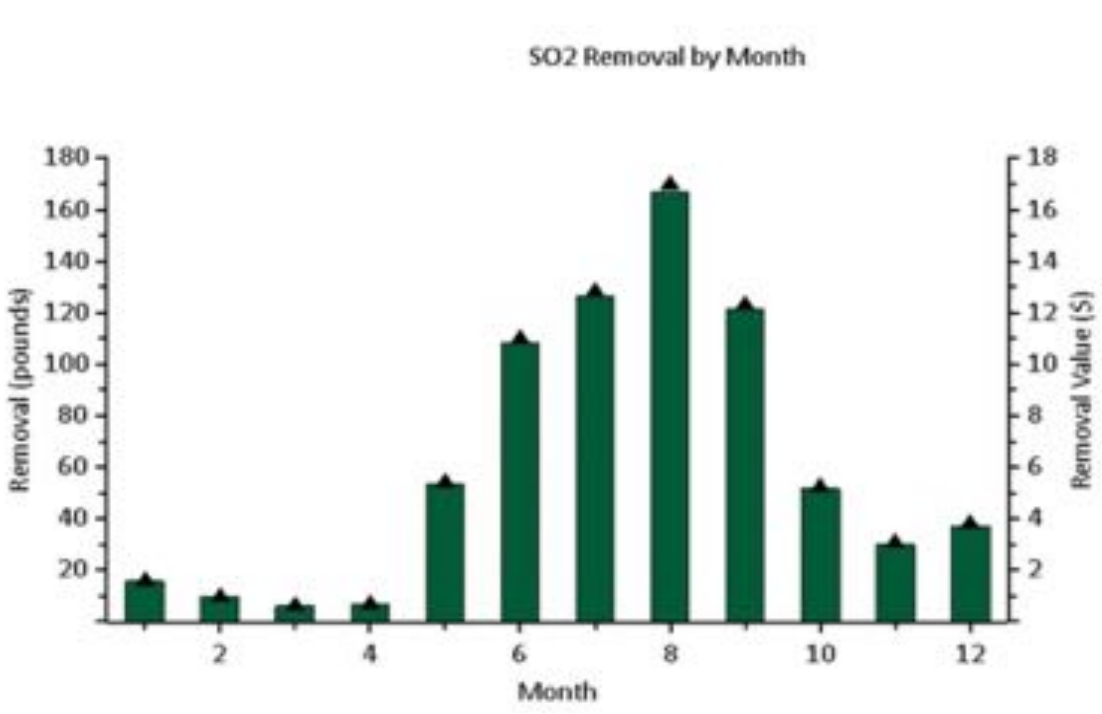
	NO2		O3		PM2.5		SO2	
	Incidence (Reduction/yr)	Value ($/yr)	Incidence (Reduction/yr)	Value ($/yr)	Incidence (Reduction/yr)	Value ($/yr)	Incidence (Reduction/yr)	Value ($/yr)
Acute Bronchitis					0.003	0.23		
Acute Myocardial Infarction					0.001	85.57		
Acute Respiratory Symptoms	0.441	13.91	5.844	499.57	1.232	120.77	0.044	1.38
Asthma Exacerbation	6.520	547.48			1.200	97.53	0.370	29.15
Chronic Bronchitis					0.001	269.17		
Emergency Room Visits	0.005	2.13	0.003	1.30	0.002	0.75	0.002	0.63
Hospital Admissions	0.012	363.34	0.007	206.76			0.001	42.16
Hospital Admissions, Cardiovascular					0.000	14.93		
Hospital Admissions, Respiratory					0.000	10.13		
Lower Respiratory Symptoms					0.032	1.69		
Mortality			0.004	29,465.74	0.004	31,911.51		
School Loss Days			2.784	273.39				
Upper Respiratory Symptoms					0.027	1.20		
Work Loss Days					0.209	34.52		
Total	**6.978**	**926.86**	**8.642**	**30,446.76**	**2.711**	**32,547.98**	**0.417**	**73.32**

EPA Environmental Benefits Mapping and Analysis Program http://www.epa.gov/airquality/benmap/index.html
Incidence: the total number of adverse health effects avoided in a year due to a change in pollution concentration
Value: the economic value that is associated with the incidence of adverse health effects

Springfield Street Tree Analysis

Pollution Removal by Trees and Shrubs - Monthly Removal

Location: Springfield, Hampden, Massachusetts, United States of America
Project: Springfield Street Trees, Series: Street Trees, Year: 2017
Generated: 4/30/2019



SO2 value is calculated based on the price of $0.10 per pound.

Springfield Street Tree Analysis

Oxygen Production of Trees by Stratum per Unit Area

Location: Springfield, Hampden, Massachusetts, United States of America
Project: Springfield Street Trees, Series: Street Trees, Year: 2017
Generated: 5/8/2019

Stratum	Oxygen Production Density (lb/yr/ac)
Bay	51.4
Memorial Square	64.3
Metro Center	58.9
Old Hill	67.5
Pine Point	97.0
Six Corners	45.8
Sixteen Acres	49.1
South End	53.9
Upper Hill	144.5
Boston Road	39.0
Brightwood	90.9
East Forest Park	146.8
East Springfield	66.1
Forest Park	130.1
Indian Orchard	67.5
Liberty Heights	113.9
McKnight	127.9
Study Area	**83.1**

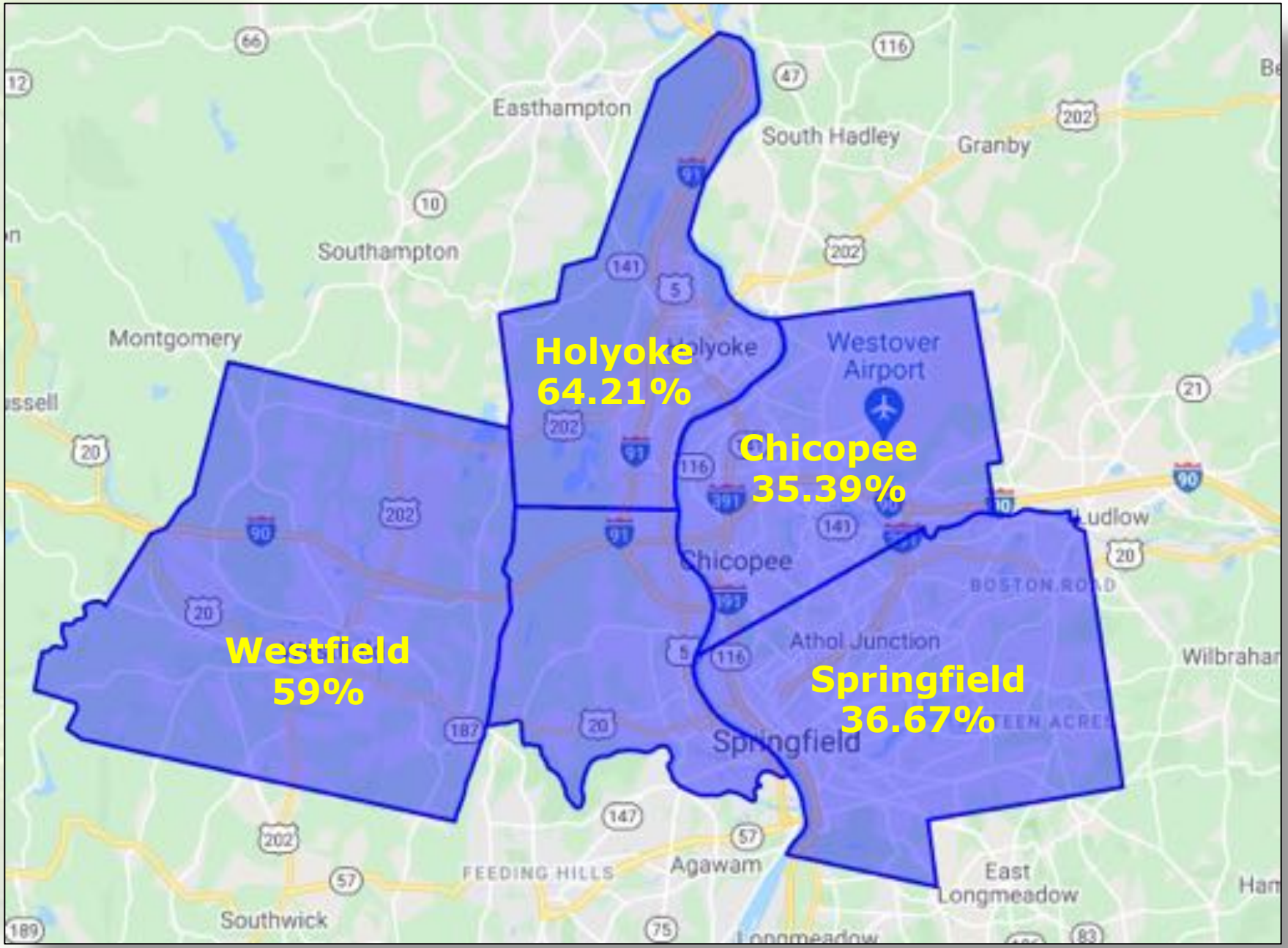
Springfield Street Tree Analysis

VOC Emissions of Trees by Stratum

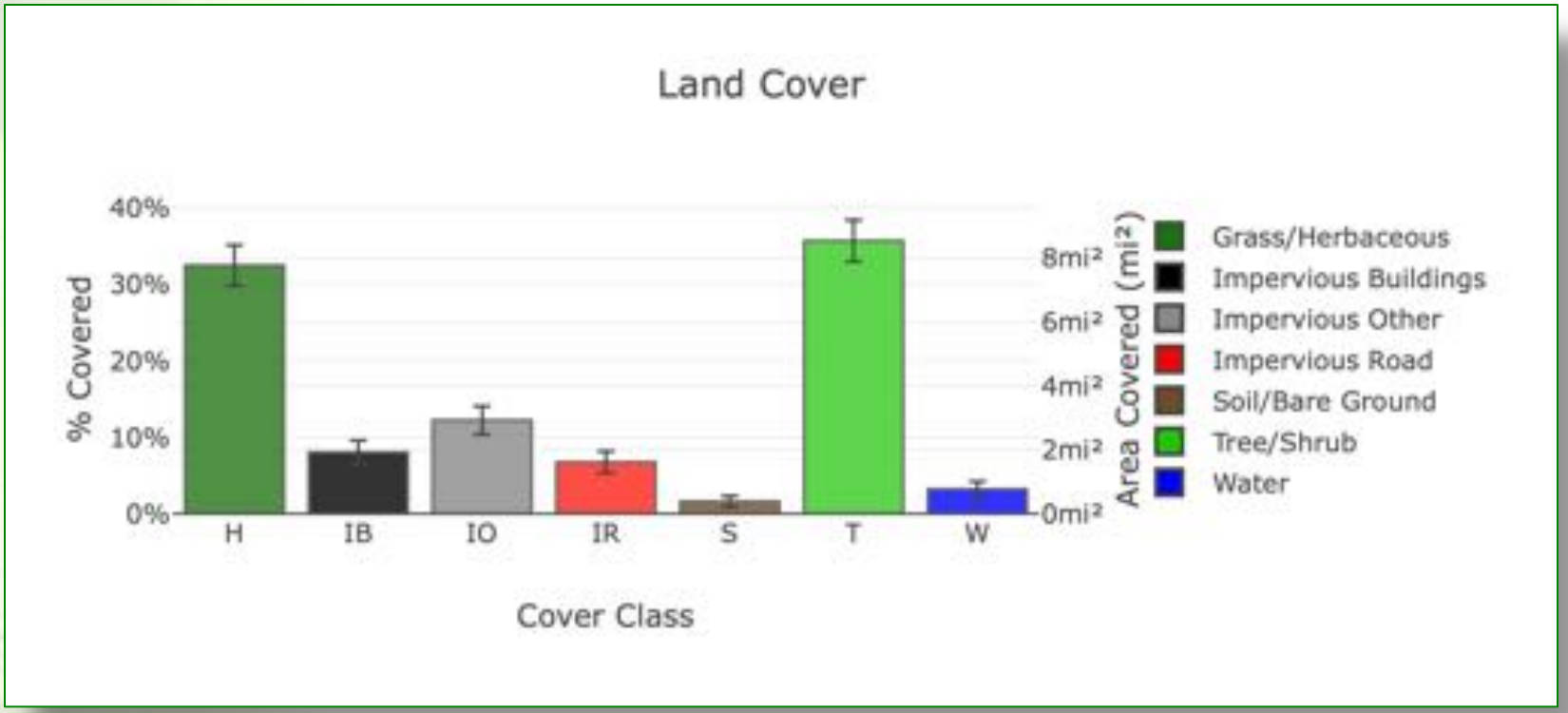
Location: Springfield, Hampden, Massachusetts, United States of America
Project: Springfield Street Trees, Series: Street Trees, Year: 2017
Generated: 4/30/2019

i-Tree

Stratum	Monoterpene (lb/yr)	Isoprene (lb/yr)	Total VOCs (lb/yr)
Bay	34.5	234.2	268.7
Boston Road	52.0	273.3	325.3
Brightwood	23.0	454.0	477.0
East Forest Park	285.5	1,295.5	1,581.1
East Springfield	196.3	609.5	805.8
Forest Park	437.6	1,966.6	2,404.1
Indian Orchard	116.3	781.5	897.8
Liberty Heights	274.0	1,014.9	1,288.9
McKnight	53.3	319.6	372.9
Memorial Square	24.6	108.7	133.3
Metro Center	18.3	259.7	278.0
Old Hill	14.0	149.2	163.2
Pine Point	161.5	1,009.7	1,171.2
Six Corners	9.8	127.2	137.0
Sixteen Acres	377.9	1,642.0	2,019.9
South End	7.2	145.8	153.0
Upper Hill	54.8	561.6	616.5
Study Area	**2,140.6**	**10,953.0**	**13,093.7**


Holyoke
64.21%
Chicopee
35.39%
Westfield
59%
Springfield
36.67%
Easthampton
South Hadley
Granby
Southampton
Montgomery
Westover Airport
Chicopee
Ludlow
Athol Junction
Springfield
Agawam
East Longmeadow
Southwick
FEEDING HILLS
BOSTON ROAD

Chicopee Urban Forest Canopy Assessment



Chicopee Urban Forest Canopy Assessment

Abbr.	Cover Class	Description	Points	% Cover ± SE	Area (mi²) ± SE
H	Grass/Herbaceous		101	32.48 ± 2.66	7.76 ± 0.63
IB	Impervious Buildings		25	8.04 ± 1.54	1.92 ± 0.37
IO	Impervious Other		38	12.22 ± 1.86	2.92 ± 0.44
IR	Impervious Road		21	6.75 ± 1.42	1.61 ± 0.34
S	Soil/Bare Ground		5	1.61 ± 0.72	0.38 ± 0.17
T	Tree/Shrub		111	35.69 ± 2.72	8.53 ± 0.65
W	Water		10	3.22 ± 1.00	0.77 ± 0.24
Total			**311**	**100.00**	**23.89**

Chicopee Urban Forest Canopy Assessment

Tree Benefit Estimates: Carbon (English units)

Description	Carbon (kT)	±SE	CO_2 Equiv. (kT)	±SE	Value (USD)	±SE
Sequestered annually in trees	6.18	±0.47	22.67	±1.73	$1,054,497	±80,264
Stored in trees (Note: this benefit is not an annual rate)	187.06	±14.24	685.90	±52.21	$31,903,958	±2,428,387

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Amount sequestered is based on 0.725 kT of Carbon, or 2.659 kT of CO_2, per mi²/yr and rounded. Amount stored is based on 21.940 kT of Carbon, or 80.446 kT of CO_2, per mi² and rounded. Value (USD) is based on $170,550.73/kT of Carbon, or $46,513.84/kT of CO_2 and rounded. (English units: kT = kilotons (1,000 tons), mi² = square miles)

Tree Benefit Estimates: Air Pollution (English units)

Abbr.	Description	Amount (lb)	±SE	Value (USD)	±SE
CO	Carbon Monoxide removed annually	1,757.85	±133.80	$1,172	±89
NO2	Nitrogen Dioxide removed annually	37,180.08	±2,829.98	$7,867	±599
O3	Ozone removed annually	229,296.63	±17,453.04	$349,463	±26,600
SO2	Sulfur Dioxide removed annually	12,058.03	±917.80	$813	±62
PM2.5	Particulate Matter less than 2.5 microns removed annually	12,348.70	±939.93	$860,392	±65,489
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	43,468.96	±3,308.66	$136,241	±10,370
Total		**336,110.26**	**±25,583.21**	**$1,355,948**	**±103,209**

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Air Pollution Estimates are based on these values in lb/m²/yr @ $/lb/yr and rounded:
CO 206.171 @ $0.67 | NO2 4,360.682 @ $0.21 | O3 26,893.155 @ $1.52 | SO2 1,414.231 @ $0.07 | PM2.5 1,448.323 @ $69.67 | PM10* 5,098.276 @ $3.13 (English units: lb = pounds, mi² = square miles)

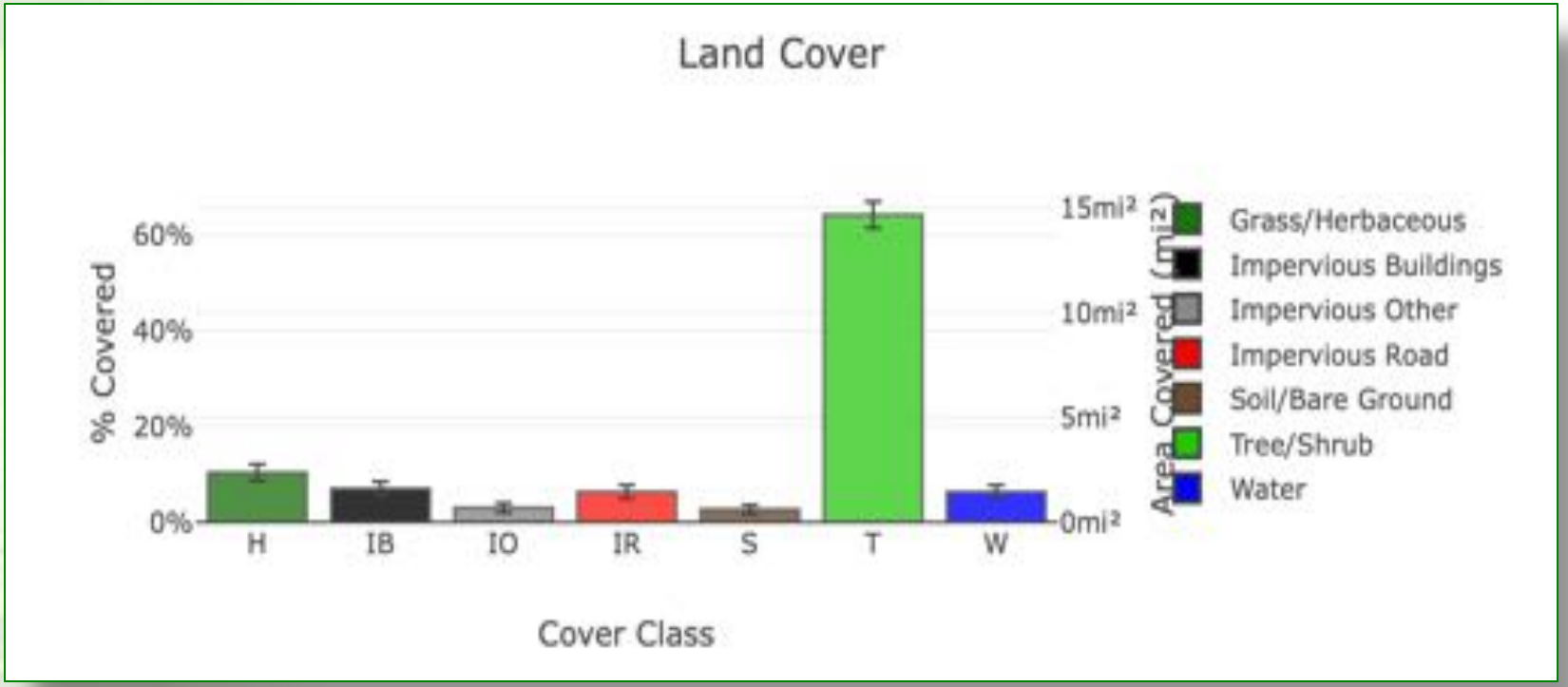
Chicopee Urban Forest Canopy Assessment

Tree Benefit Estimates: Hydrological (English units)

Abbr.	Benefit	Amount (Mgal)	±SE	Value (USD)	±SE
AVRO	Avoided Runoff	70.45	±5.36	$629,565	±47,920
E	Evaporation	389.45	±29.64	N/A	N/A
I	Interception	390.19	±29.70	N/A	N/A
T	Transpiration	596.61	±45.41	N/A	N/A
PE	Potential Evaporation	3,175.06	±241.67	N/A	N/A
PET	Potential Evapotranspiration	2,322.30	±176.76	N/A	N/A

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Hydrological Estimates are based on these values in Mgal/(mi²)/yr @ $/Mgal/yr and rounded:
AVRO 8.263 @ $8,936.00 | E 45.676 @ N/A | I 45.764 @ N/A | T 69.973 @ N/A | PE 372.388 @ N/A | PET 272.372 @ N/A (English units: Mgal = millions of gallons, mi² = square miles)

Holyoke Urban Forest Canopy Assessment



Holyoke Urban Forest Canopy Assessment

Abbr.	Cover Class	Description	Points	% Cover ± SE	Area (mi²) ± SE
H	Grass/Herbaceous		31	10.37 ± 1.76	2.37 ± 0.40
IB	Impervious Buildings		21	7.02 ± 1.48	1.60 ± 0.34
IO	Impervious Other		9	3.01 ± 1.00	0.69 ± 0.23
IR	Impervious Road		19	6.35 ± 1.41	1.45 ± 0.32
S	Soil/Bare Ground		8	2.68 ± 0.95	0.61 ± 0.22
T	Tree/Shrub		192	64.21 ± 2.77	14.67 ± 0.63
W	Water		19	6.35 ± 1.41	1.45 ± 0.32
Total			**299**	**100.00**	**22.85**

Holyoke Urban Forest Canopy Assessment

Tree Benefit Estimates: Carbon (English units)

Description	Carbon (kT)	±SE	CO_2 Equiv. (kT)	±SE	Value (USD)	±SE
Sequestered annually in trees	10.64	±0.46	39.01	±1.68	$1,814,714	±78,345
Stored in trees (Note: this benefit is not an annual rate)	321.92	±13.90	1,180.39	±50.96	$54,904,431	±2,370,353

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Amount sequestered is based on 0.725 kT of Carbon, or 2.659 kT of CO_2, per mi^2/yr and rounded. Amount stored is based on 21.940 kT of Carbon, or 80.446 kT of CO_2, per mi^2 and rounded. Value (USD) is based on $170,550.73/kT of Carbon, or $46,513.84/kT of CO_2 and rounded. (English units: kT = kilotons (1,000 tons), mi^2 = square miles)

Tree Benefit Estimates: Air Pollution (English units)

Abbr.	Description	Amount (T)	±SE	Value (USD)	±SE
CO	Carbon Monoxide removed annually	1.51	±0.07	$2,017	±87
NO2	Nitrogen Dioxide removed annually	31.99	±1.38	$13,539	±584
O3	Ozone removed annually	197.30	±8.52	$601,401	±25,964
SO2	Sulfur Dioxide removed annually	10.38	±0.45	$1,398	±60
PM2.5	Particulate Matter less than 2.5 microns removed annually	10.63	±0.46	$1,480,674	±63,924
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	37.40	±1.61	$234,462	±10,122
Total		**289.21**	**±12.49**	**$2,333,490**	**±100,742**

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Air Pollution Estimates are based on these values in T/mi^2/yr @ $/T/yr and rounded:
CO 0.103 @ $1,333.50 | NO2 2.180 @ $423.19 | O3 13.447 @ $3,048.13 | SO2 0.707 @ $134.78 | PM2.5 0.724 @ $139,349.40 | PM10* 2.549 @ $6,268.44 (English units: T = tons (2,000 pounds), mi^2 = square miles)

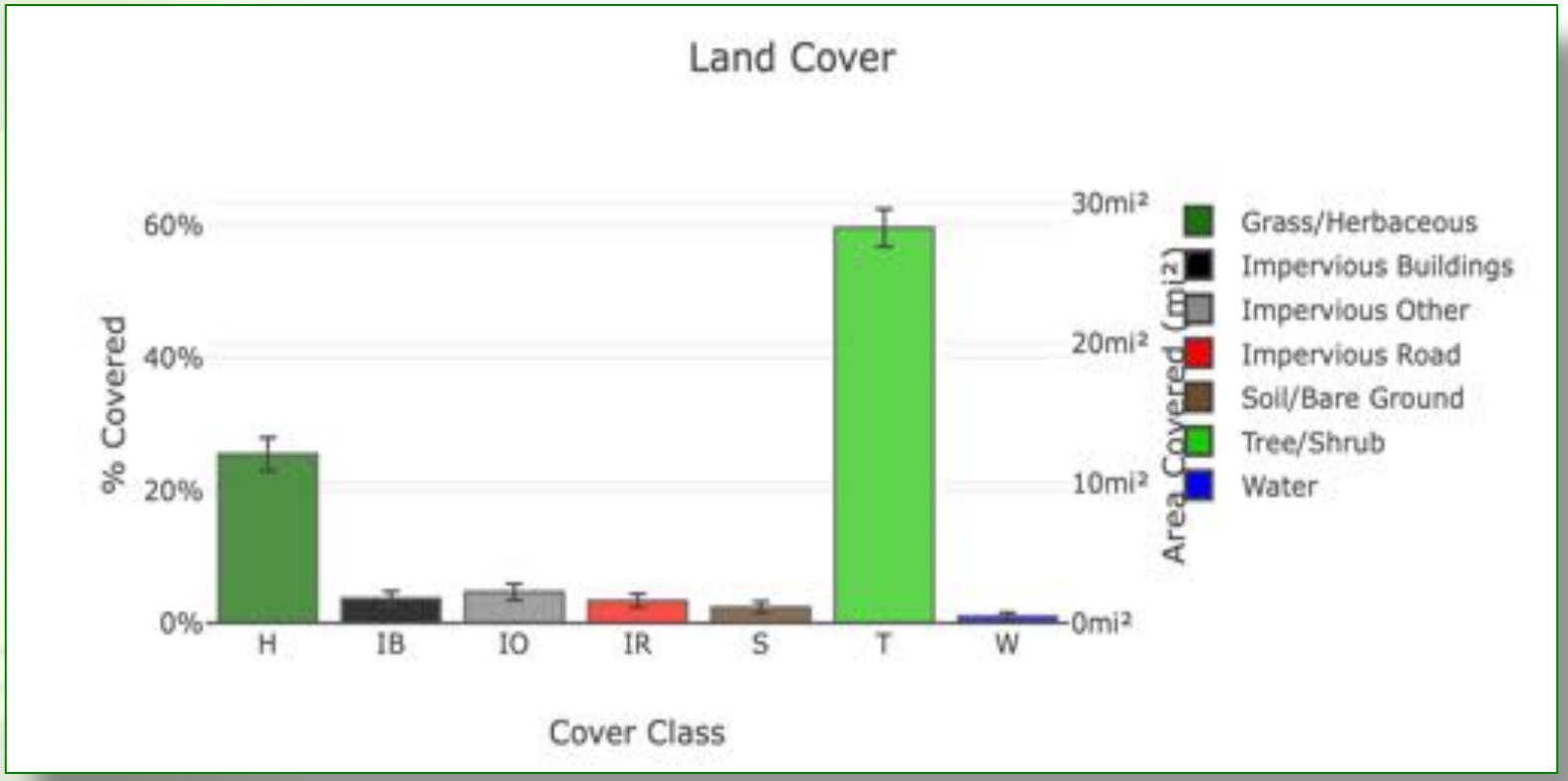
Holyoke Urban Forest Canopy Assessment

Tree Benefit Estimates: Hydrological (English units)

Abbr.	Benefit	Amount (Mgal)	±SE	Value (USD)	±SE
AVRO	Avoided Runoff	121.24	±5.23	$1,083,436	±46,774
E	Evaporation	670.21	±28.93	N/A	N/A
I	Interception	671.49	±28.99	N/A	N/A
T	Transpiration	1,026.72	±44.33	N/A	N/A
PE	Potential Evaporation	5,464.05	±235.90	N/A	N/A
PET	Potential Evapotranspiration	3,996.52	±172.54	N/A	N/A

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Hydrological Estimates are based on these values in Mgal/mi²/yr @ $/Mgal/yr and rounded:
AVRO 8.263 @ $8,936.00 | E 45.676 @ N/A | I 45.764 @ N/A | T 69.973 @ N/A | PE 372.388 @ N/A | PET 272.372 @ N/A (English units: Mgal = millions of gallons, mi² = square miles)

Westfield Urban Forest Canopy Assessment



Westfield Urban Forest Canopy Assessment

Abbr.	Cover Class	Description	Points	% Cover ± SE	Area (mi²) ± SE
H	Grass/Herbaceous		76	25.42 ± 2.52	12.05 ± 1.19
IB	Impervious Buildings		11	3.68 ± 1.09	1.74 ± 0.52
IO	Impervious Other		14	4.68 ± 1.22	2.22 ± 0.58
IR	Impervious Road		10	3.34 ± 1.04	1.59 ± 0.49
S	Soil/Bare Ground		7	2.34 ± 0.88	1.11 ± 0.42
T	Tree/Shrub		178	59.53 ± 2.84	28.23 ± 1.35
W	Water		3	1.00 ± 0.58	0.48 ± 0.27
Total			**299**	**100.00**	**47.42**

Westfield Urban Forest Canopy Assessment

Tree Benefit Estimates: Carbon (English units)

Description	Carbon (kT)	±SE	CO_2 Equiv. (kT)	±SE	Value (USD)	±SE
Sequestered annually in trees	20.47	±0.98	75.06	±3.58	$3,491,174	±166,463
Stored in trees (Note: this benefit is not an annual rate)	619.32	±29.53	2,270.85	±108.28	$105,625,981	±5,036,373

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Amount sequestered is based on 0.725 kT of Carbon, or 2.659 kT of CO_2 per mi²/yr and rounded. Amount stored is based on 21.940 kT of Carbon, or 80.446 kT of CO_2, per mi² and rounded. Value (USD) is based on $170,550.73/kT of Carbon, or $46,513.84/kT of CO_2 and rounded. (English units: kT = kilotons (1,000 tons), mi² = square miles)

Tree Benefit Estimates: Air Pollution (English units)

Abbr.	Description	Amount (T)	±SE	Value (USD)	±SE
CO	Carbon Monoxide removed annually	2.91	±0.14	$3,880	±185
NO2	Nitrogen Dioxide removed annually	61.55	±2.93	$26,046	±1,242
O3	Ozone removed annually	379.57	±18.10	$1,156,984	±55,166
SO2	Sulfur Dioxide removed annually	19.96	±0.95	$2,690	±128
PM2.5	Particulate Matter less than 2.5 microns removed annually	20.44	±0.97	$2,848,542	±135,822
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	71.96	±3.43	$451,061	±21,507
Total		**556.39**	**±26.53**	**$4,489,204**	**±214,051**

Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Air Pollution Estimates are based on these values in T/(mi²)/yr @ $/(T)/yr and rounded:

CO 0.103 @ $1,333.50 | NO2 2.180 @ $423.19 | O3 13.447 @ $3,048.13 | SO2 0.707 @ $134.78 | PM2.5 0.724 @ $139,349.40 | PM10* 2.549 @ $6,268.44 (English units: T = tons (2,000 pounds), mi² = square miles)

Westfield Urban Forest Canopy Assessment

Tree Benefit Estimates: Hydrological (English units)

Abbr.	Benefit	Amount (Mgal)	±SE	Value (USD)	±SE
AVRO	Avoided Runoff	233.25	±11.12	$2,084,330	±99,383
E	Evaporation	1,289.36	±61.48	N/A	N/A
I	Interception	1,291.82	±61.60	N/A	N/A
T	Transpiration	1,975.21	±94.18	N/A	N/A
PE	Potential Evaporation	10,511.83	±501.22	N/A	N/A
PET	Potential Evapotranspiration	7,688.56	±366.60	N/A	N/A

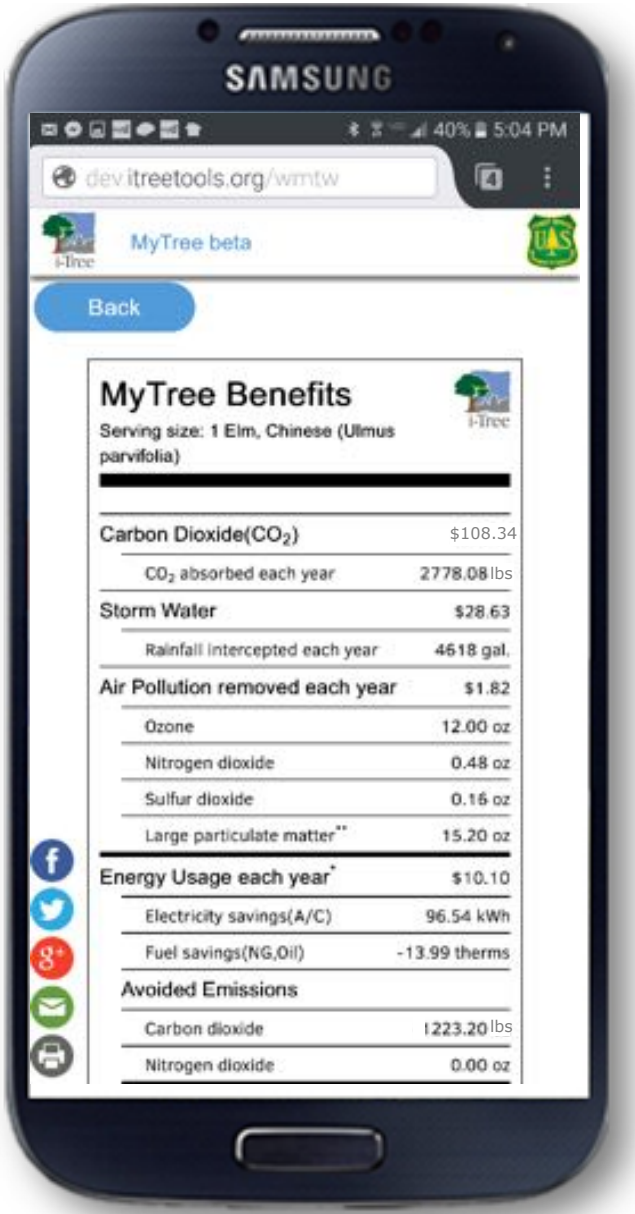
Currency is in USD and rounded. Standard errors of removal and benefit amounts are based on standard errors of sampled and classified points. Hydrological Estimates are based on these values in Mgal/(mi²)/yr @ $/Mgal/yr and rounded:
AVRO 8,263 @ $8,936.00 | E 45,676 @ N/A | I 45,764 @ N/A | T 69,973 @ N/A | PE 372,388 @ N/A | PET 272,372 @ N/A (English units: Mgal = millions of gallons, mi² = square miles)

MyTree Personal Tree Value Calculator

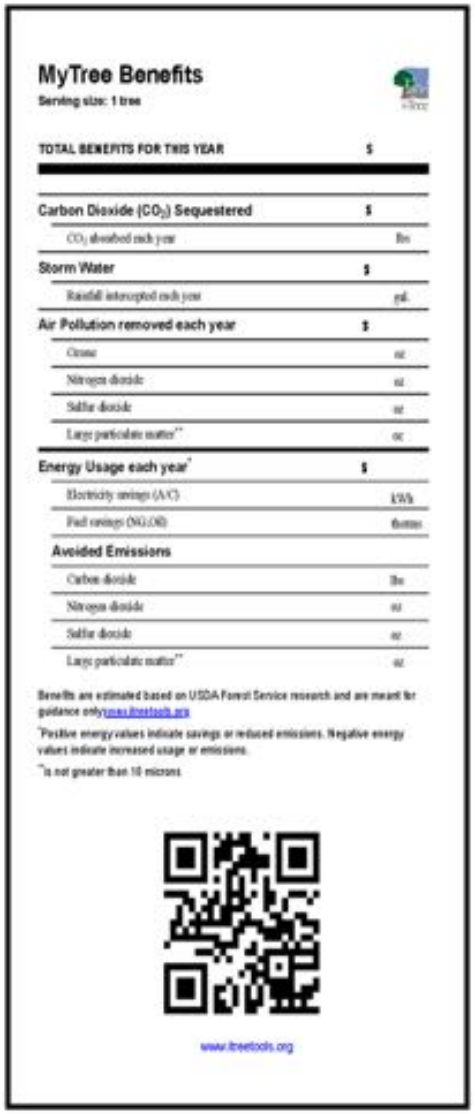
Learn about benefits that trees provide!

Tell us a little bit about your tree and we'll estimate the amount of **carbon dioxide** and pollution it removes from the air, as well as the amount of **stormwater** it can help mitigate.

It's quick and easy!



MyTree Personal Tree Value Calculator



MyTree Benefits

Serving size: 1 tree

TOTAL BENEFITS FOR THIS YEAR	**$**
Carbon Dioxide (CO_2) Sequestered	**$**
CO_2 absorbed each year	lbs
Storm Water	**$**
Rainfall intercepted each year	gal.
Air Pollution removed each year	**$**
Ozone	oz
Nitrogen dioxide	oz
Sulfur dioxide	oz
Large particulate matter**	oz
Energy Usage each year*	**$**
Electricity savings (A/C)	kWh
Fuel savings (NG,OH)	therms
Avoided Emissions	
Carbon dioxide	lbs
Nitrogen dioxide	oz
Sulfur dioxide	oz
Large particulate matter**	oz

Benefits are estimated based on USDA Forest Service research and are meant for guidance only www.itreetools.org

*Positive energy values indicate savings or reduced emissions. Negative energy values indicate increased usage or emissions.

**Is not greater than 10 microns

www.itreetools.org

MyTree Personal Tree Value Calculator

Tree Facts

Serving Size: 14 in DBH (35.6 cm)
Species: Pin Oak, ***Quercus palustris***

Amount Per Serving

Carbon sequestered 259 lbs avoided 257 lbs

% Annual Value*

Total Carbon 537 lbs

O3 $1.96

VOC(Volatile Organic Compounds) $0.93

NO2(Deposited) $0.85

NO2(Avoided) $3.36

SO2(Deposited) $0.25

SO2(Avoided) $1.40

PM10(Deposited) $1.77

PM10(Avoided) $0.39

Conserved Kilowatt/hours 96 KwH

Reduced oil/natural gas consumption 28 therm(s)

Stormwater intercepted 1,527 gallons

Property value increase $103.00	Natural Gas $39.93
Stormwater $12.21	Electricity $12.92

*It should be noted that trees themselves emit biogenic volatile organic compounds (BVOCs) which can contribute to ground-level ozone production. This may negate the positive impact the tree has on ozone mitigation for some high emitting species (e.g. Willow Oak or Sweetgum). However, the sum total of the tree's environmental benefits always trumps this negative.

Source
www.treebenefits.com/calculator/ReturnValues.cfm?climatezone=Northeast

USDA Forest Service's Center for Urban Forest Research

i-Tree Tools CD ROM: http://www.itreetools.org/

MyTree Personal Tree Value Calculator