Spring 2023 – i-Tree Open Academy

Session 1: **Introduction to i-Tree**

Understanding the benefits of trees for people, places, and planning

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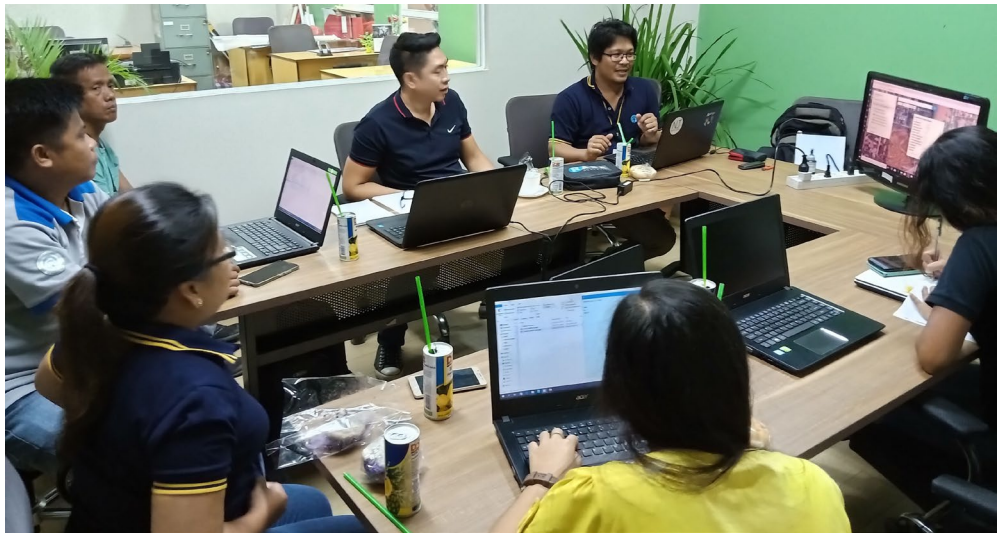
Plan for today

1. What is i-Tree?
2. What results can I get from i-Tree?
3. Overview of the 2023 i-Tree tools
4. Introduction to the science of i-Tree
5. Example i-Tree uses

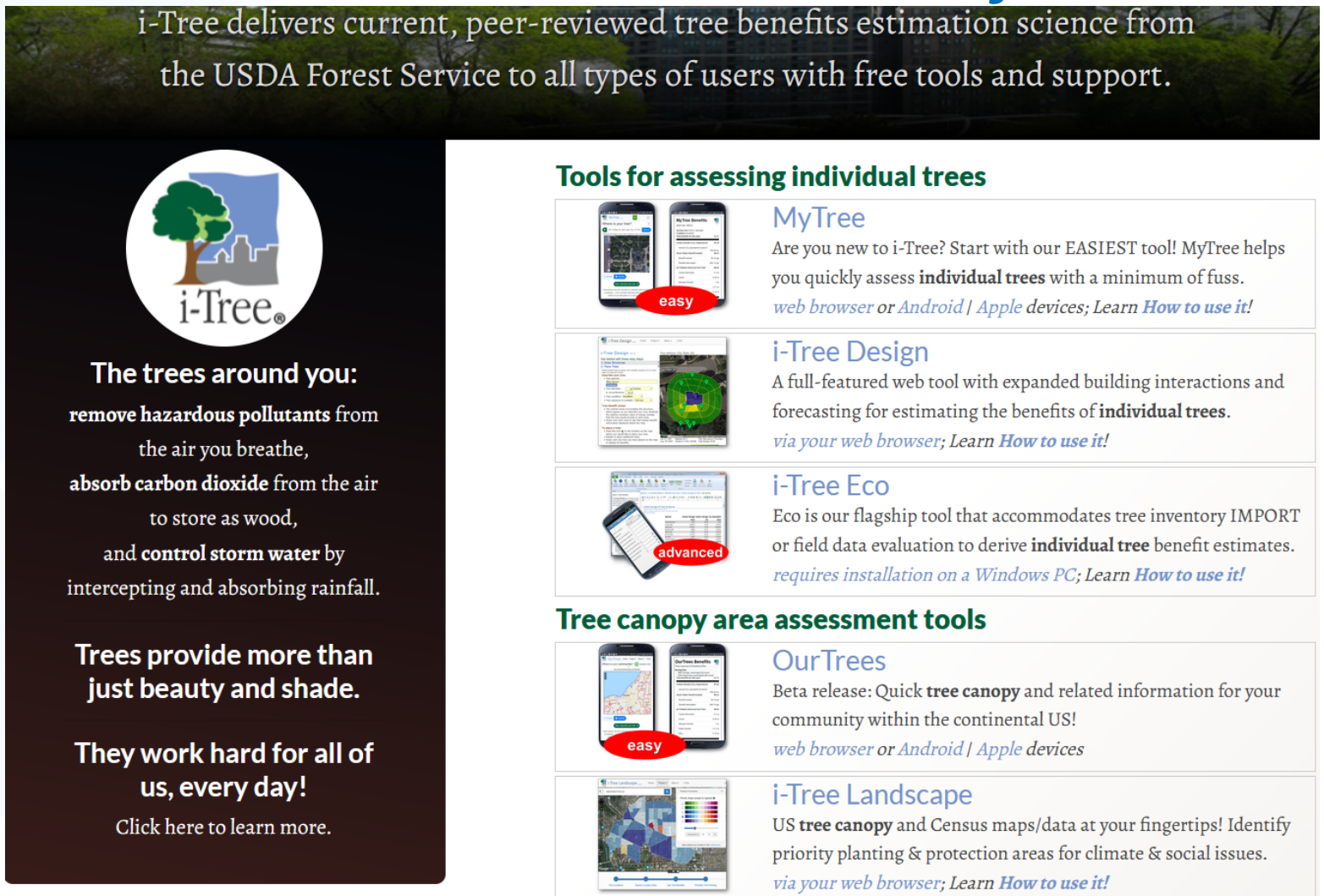


What is i-Tree?

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

- Public domain science
- Free tools
- Technical support
- Continuously improved

www.itreetools.org



i-Tree is a Cooperative Initiative

DAVEY

Arbor Day Foundation

sma SOCIETY OF MUNICIPAL ARBORISTS

ISA

Casey Trees

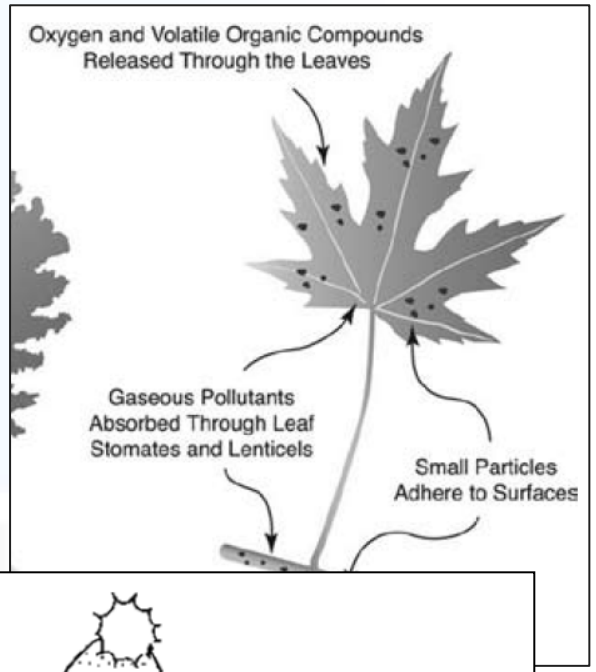
ESF

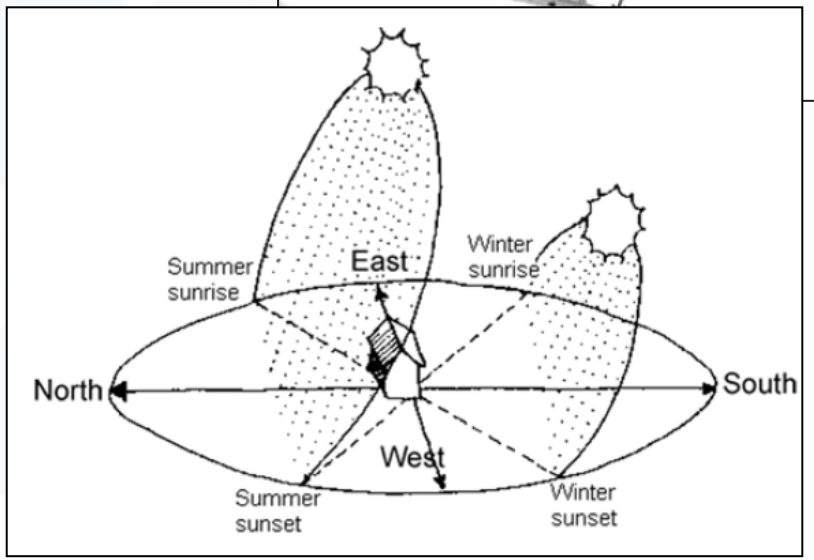
i-Tree's Vision

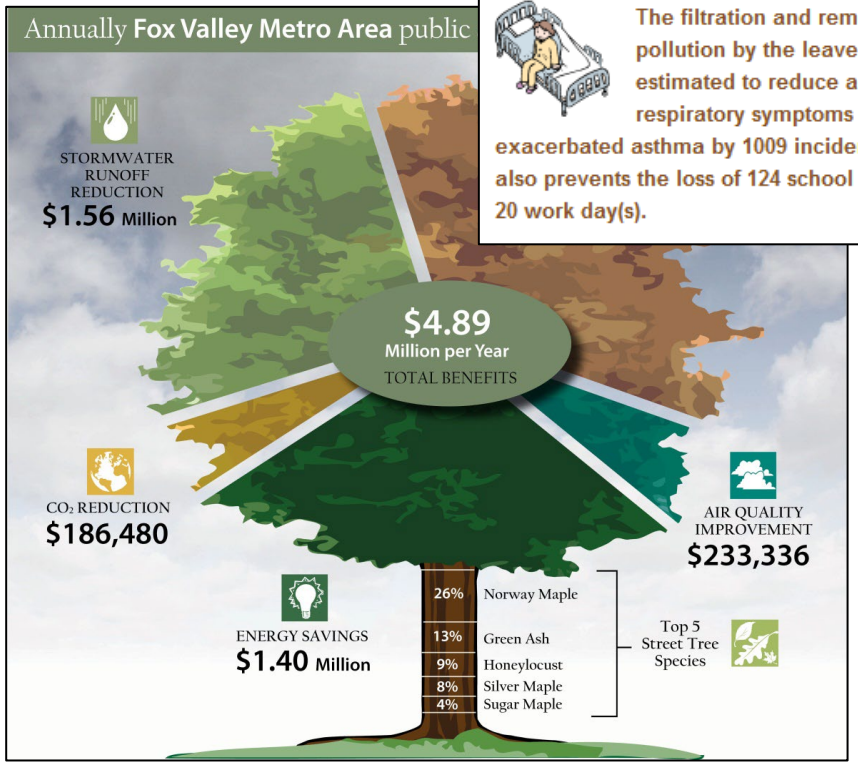
To improve forest and human health, and forest and city resiliency through easy-to-use technology that engages people globally in enhancing forest management.

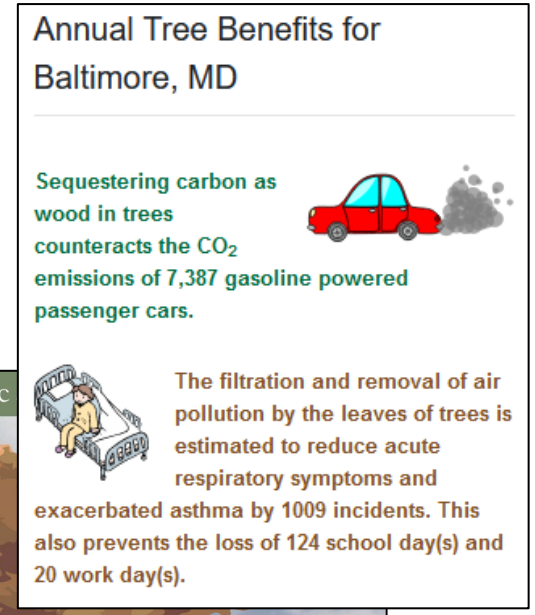
i-Tree Demonstrating tree value

Structure → Function → Value

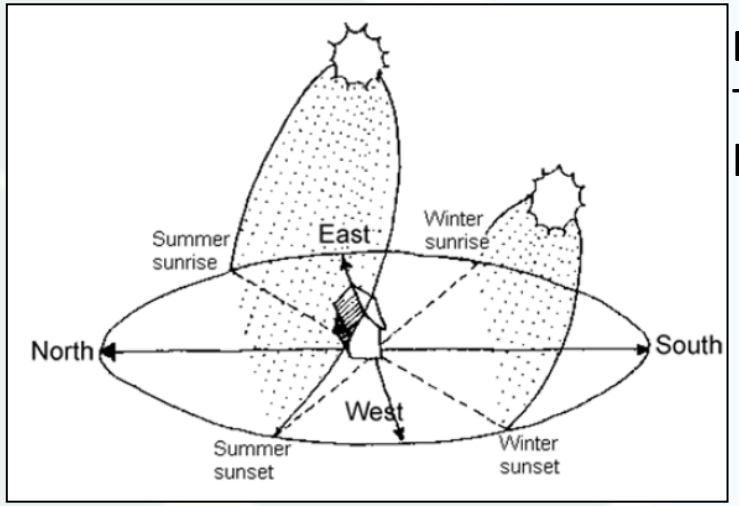






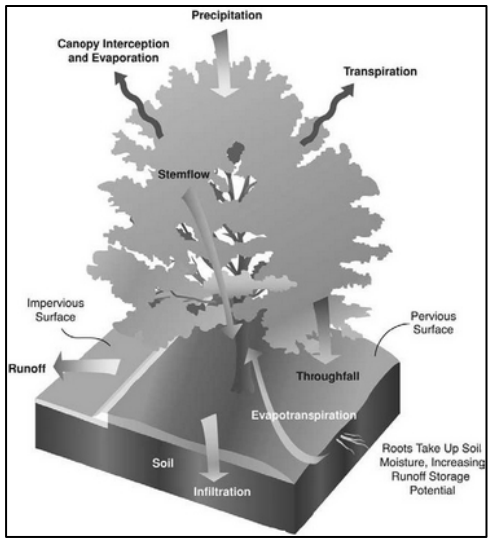


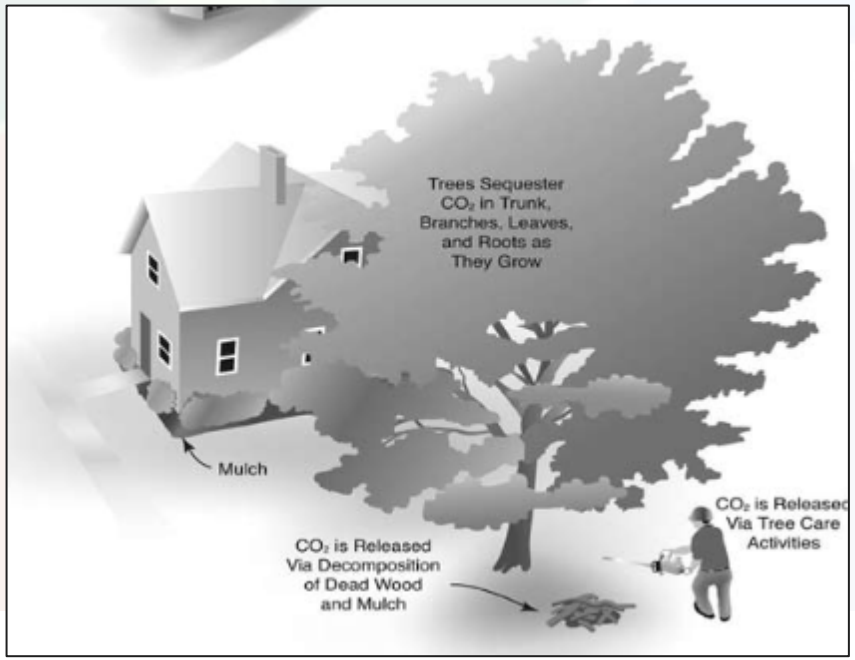
What does i-Tree Estimate and Why?



Energy
Tree impacts on heating and cooling

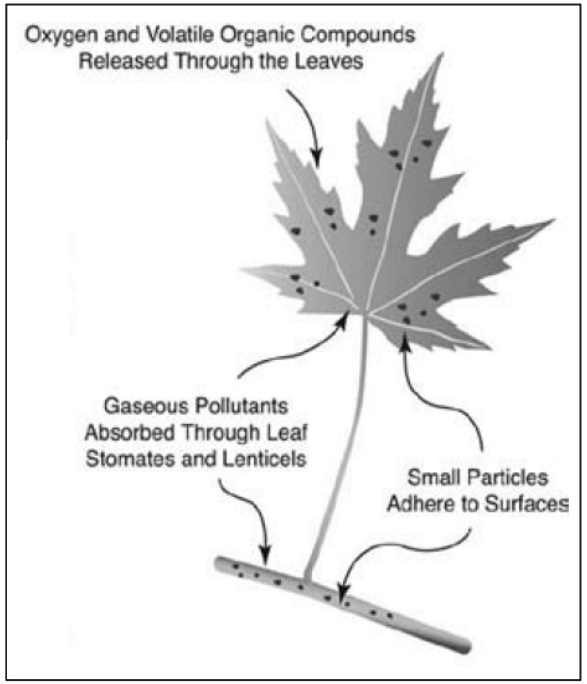
Stormwater
Avoided runoff, evaporation, transpiration



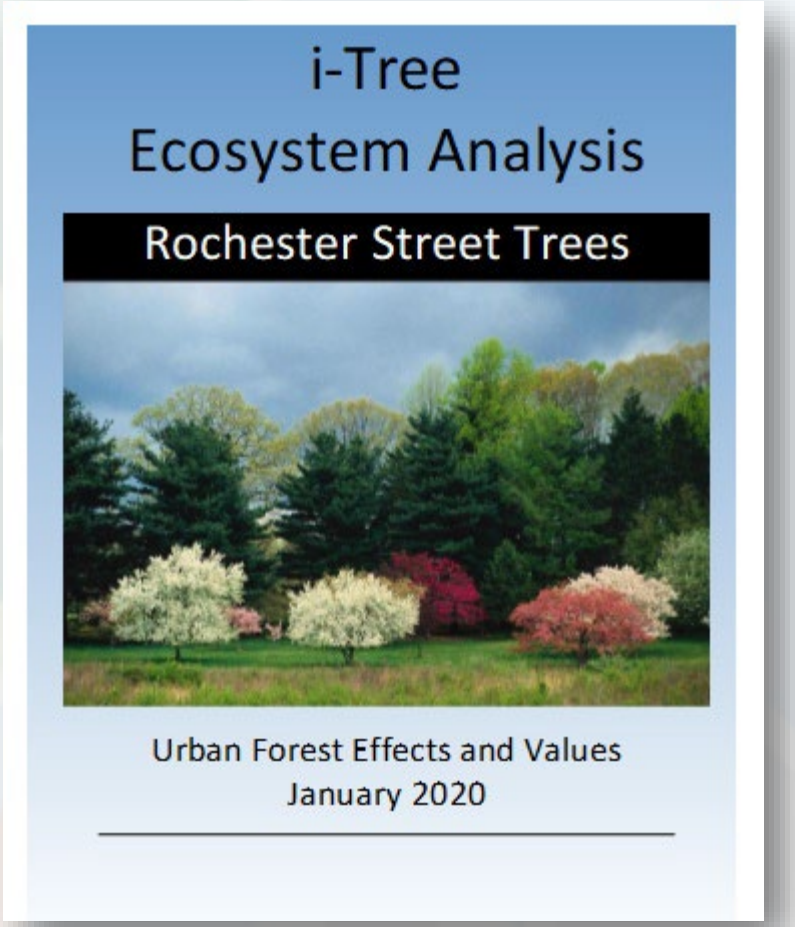


Carbon dioxide
Storage and sequestration of a greenhouse gas

Air Quality
Interaction with EPA criterion pollutants resulting in improved health



Example: What does i-Tree estimate?



**Some analyses and report options are limited to the US location and certain types of project*

- **Structure** – *leaf area, condition, species distribution, importance values*
- **Function**
  - Carbon
  - Hydrology effects
  - Energy effects *
  - Air pollution removal
  - Human health impacts *
  - Volatile organic compounds (VOCs)
  - Ultraviolet (UV) reduction
- **Value ($)**

Management information

  - Pest & disease susceptibility *
  - Limited tree maintenance needs
  - User defined options (3)
- **Wildlife suitability** *
- **Forecasting**
- **Cost benefit ratio anlaysis**

Example: What does i-Tree estimate?

- Number of downtown trees: 9,755 Tree cover: 126.33 acres
- Pollution removal: 2.6 tons/year
  $14.5 thousand/year
- Carbon storage: 4,845 tons
  $645 thousand
- Carbon sequestration: 83.1 tons/year
  $11.1 thousand/year
- Avoided runoff: 200,100 cubic feet/year ($13.4 thousand/year)
- Replacement values: $11.3 million

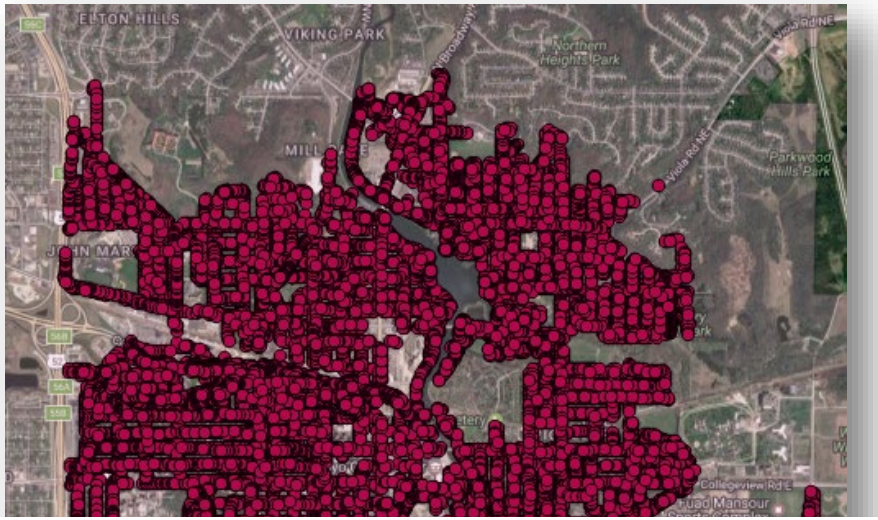


Table 1. Most important species in Rochester Street Trees

Species Name	*Percent Population*	*Percent Leaf Area*	*IV*
Acer platanoides	15.3	27.7	43.0
Fraxinus pennsylvanica	5.2	9.5	14.7
Acer saccharum	5.8	8.1	13.9
Celtis occidentalis	5.2	6.8	12.0
Picea	5.9	5.9	11.8
Malus	7.7	3.3	11.0
Gleditsia triacanthos	6.4	3.7	10.1
Ulmus americana	3.6	4.2	7.8
Tilia cordata	3.2	3.9	7.1
Acer saccharinum	2.5	4.4	6.9

The 2023 i-Tree Suite of Tools

i-Tree

Core individual tree tools

*

*

Core canopy tools

*

Utilities

*

*

*

*

*

. . .

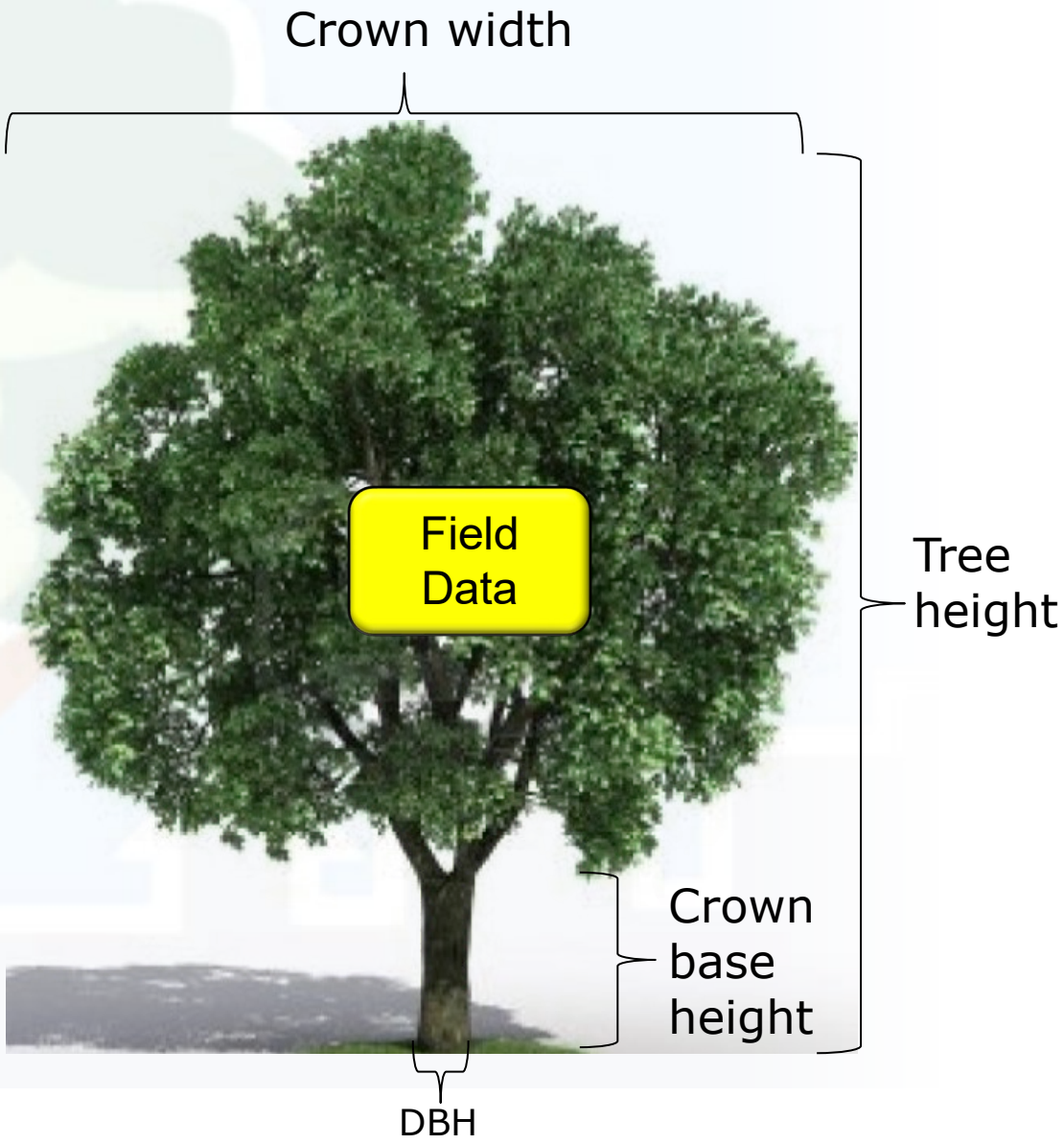
* *i-Tree Tools that can be used internationally*

i-Tree

i-Tree is a Cooperative Initiative among these partners

USFS · DAVEY · Arbor Day Foundation · SMA Society of Municipal Arborists · ISA · Casey Trees · ESF State University of New York College of Environmental Science and Forestry

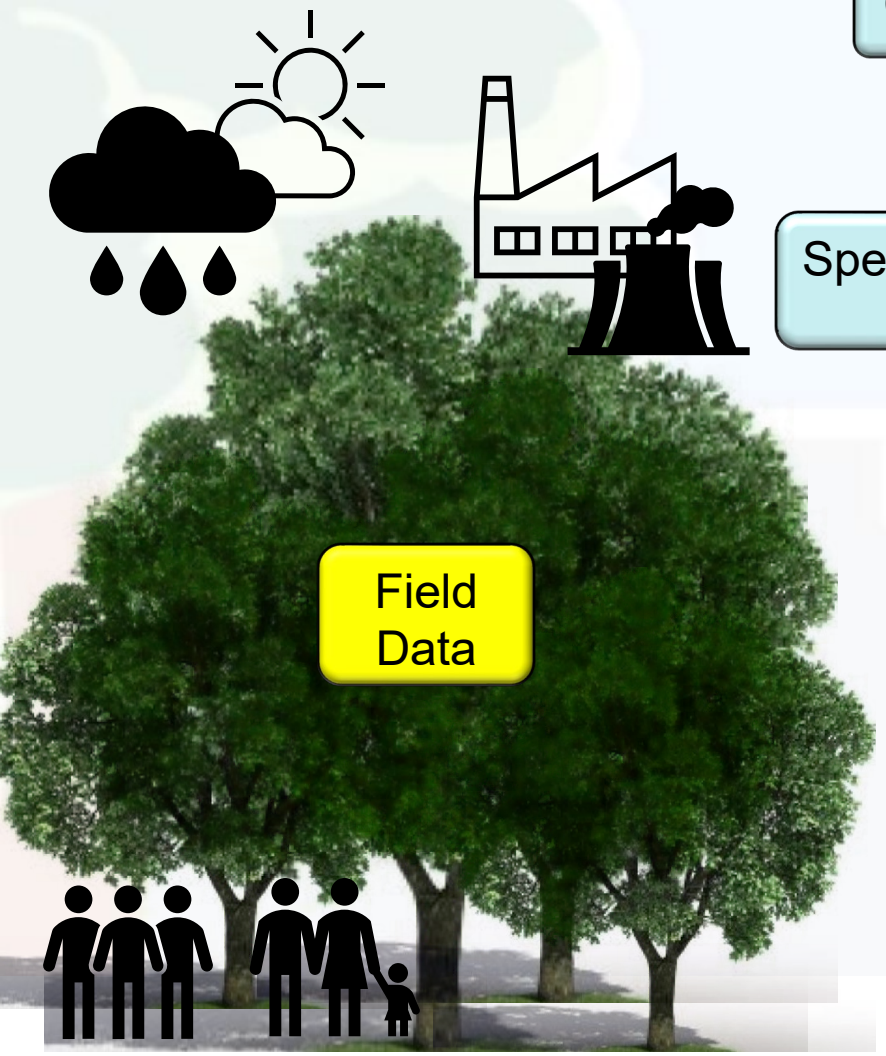
i-Tree model basics: Inventory data ➡ tree benefits?



Key field variables

- DBH
- Crown measurements
- Species
- Tree health
- Building interactions
- Light availability

i-Tree model basics: Inventory data ➡ tree benefits?



Field Data

City Data

Pollution Data

Weather Data

Species Data (8000+)

Location Data

i-Tree Eco

Carbon

Air Quality

Hydrology

Energy

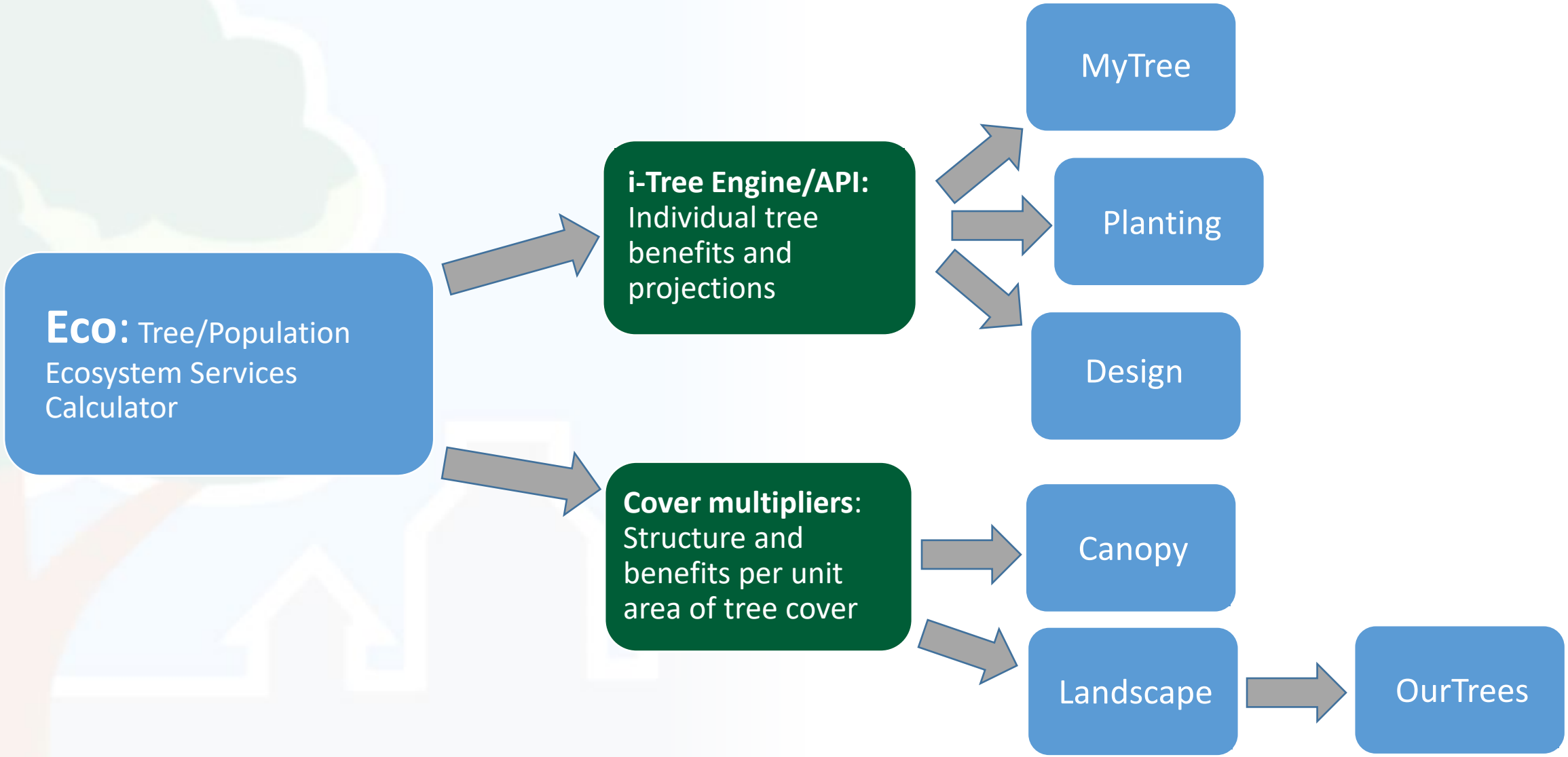
Volatile Organic Compounds

Structure

Value

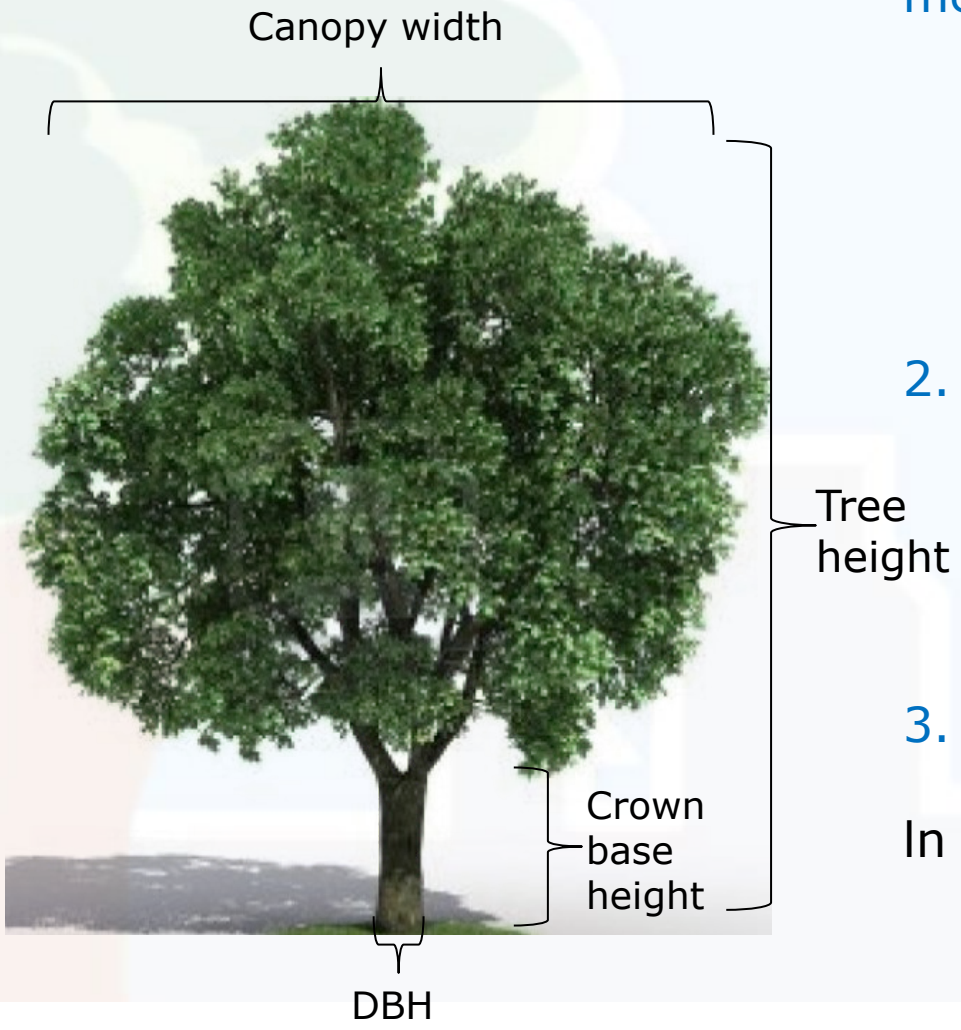
Forecast

i-Tree Tool Relationships



Science of i-Tree - Air pollution benefits

Step 1: Estimate tree structure: Leaf surface area



1. With at least dbh and species we can predict crown size measurements

Red maple height = $e^{(2.6393 + (\ln(DBH) * 0.5613))}$

18 in dbh red maple has an estimate height of 70 ft

2. With crown size measurements we can estimate crown volume

3. With volume we can estimate leaf surface area

ln of leaf area = -4.33 + 0.29 * ht +
+0.7312 * crown diam
+ 5.72 species leaf density
+ -0.015 crown surface area

Leaf surface area for our 18 in red maple =
5,842 sq ft

Leaf surface area of 18” dbh trees

Eastern white pine

5,516 sq ft

Honeylocust

4,281 sq ft

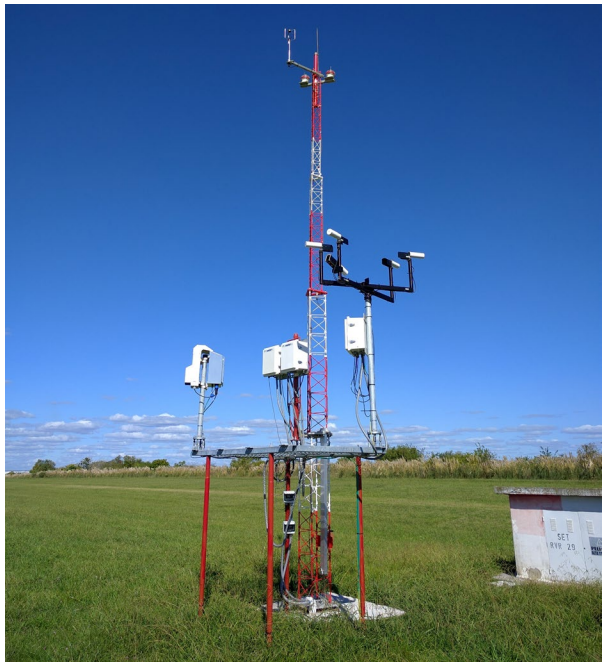
Northern red oak

6,038 sq ft

Step 2: Estimate tree function

Gas exchange - NO_2, O_3, SO_2

Deposition - particulate matter (PM2.5) and CO



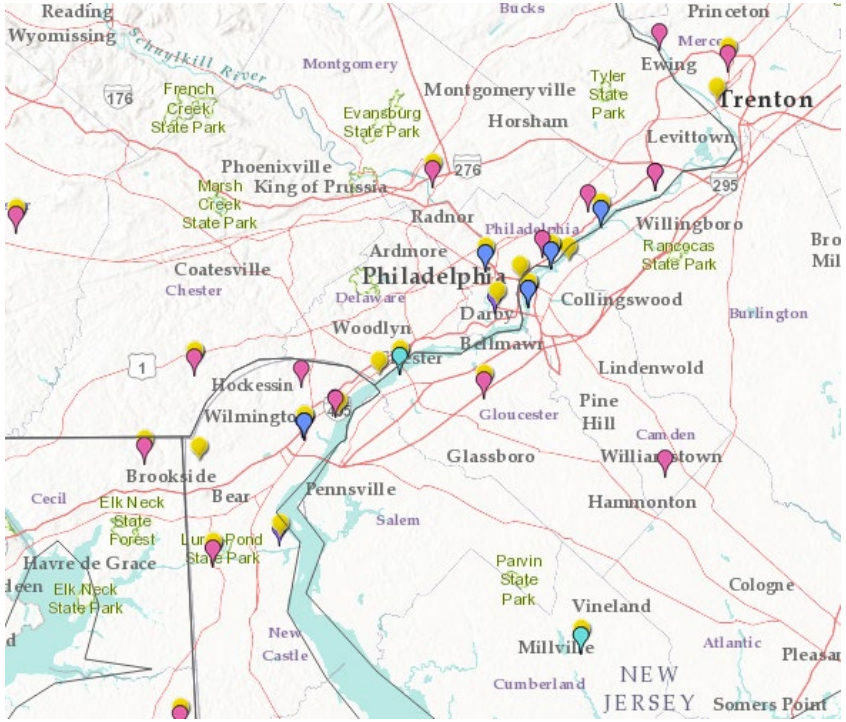
Local hourly weather data:

- windspeed
- sunlight
- rainfall
- humidity

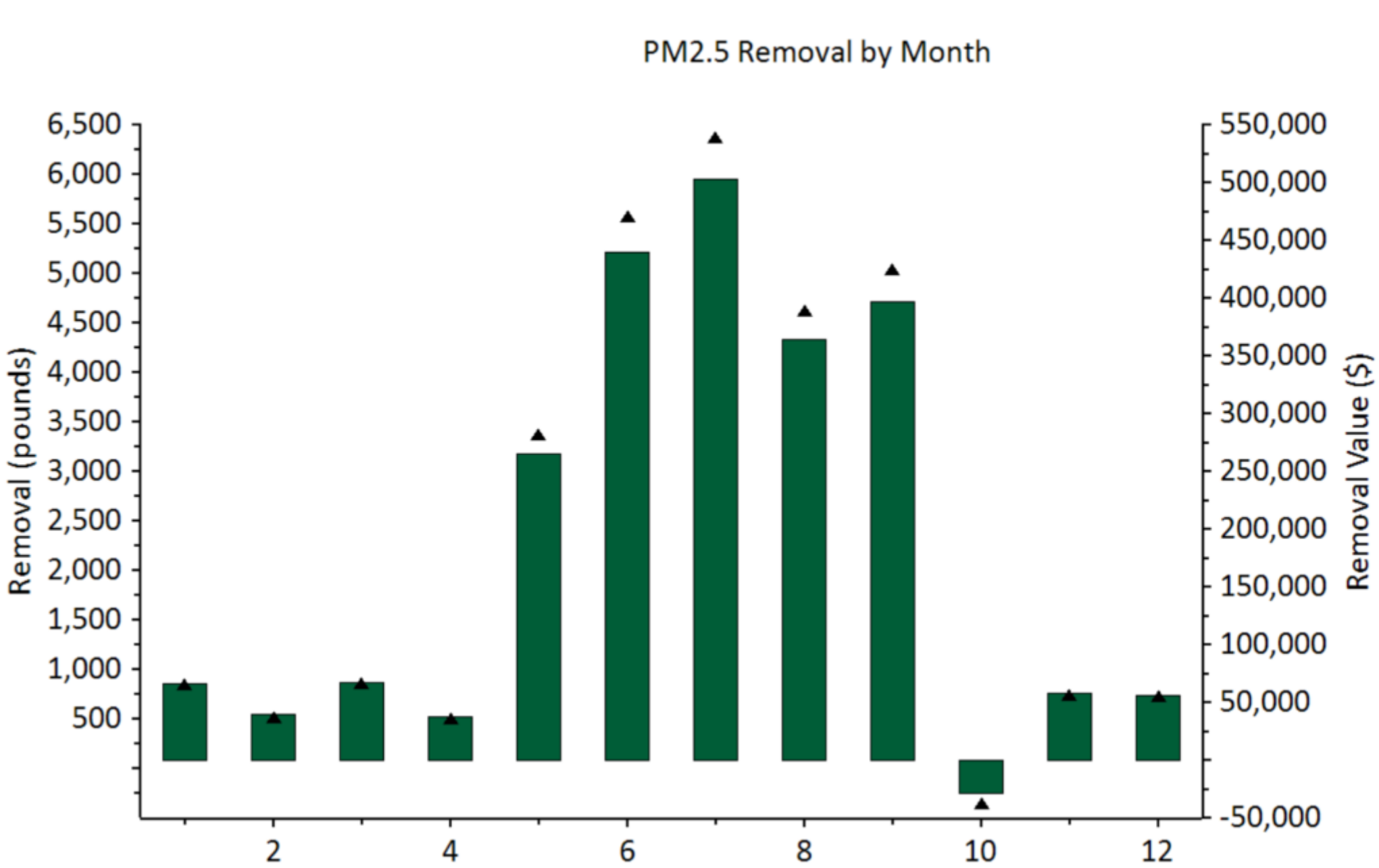
Local hourly pollution data

Tree structure data

- Leaf area
- Leaf on/off dates
- Deciduous vs. evergreen



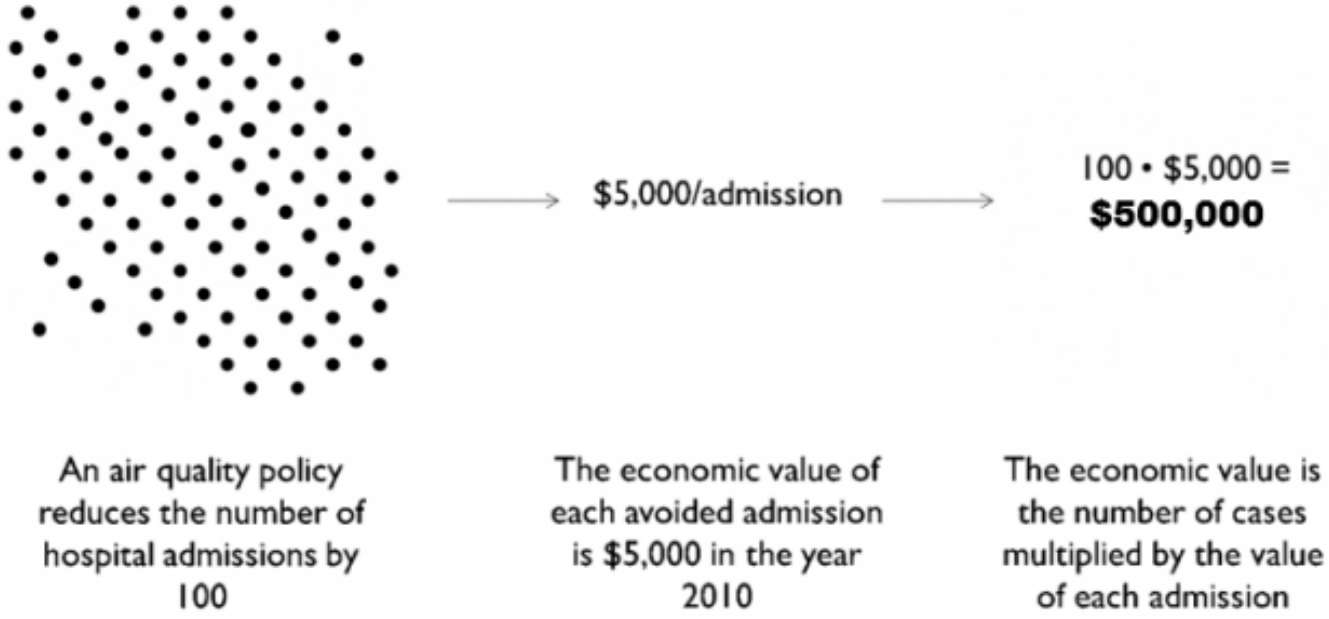
Pollution removal



Step 3: Estimating value
Monetary value of pollution removal by trees

United States Environmental Protection Agency

Benefits Mapping and analysis program (BenMAP)

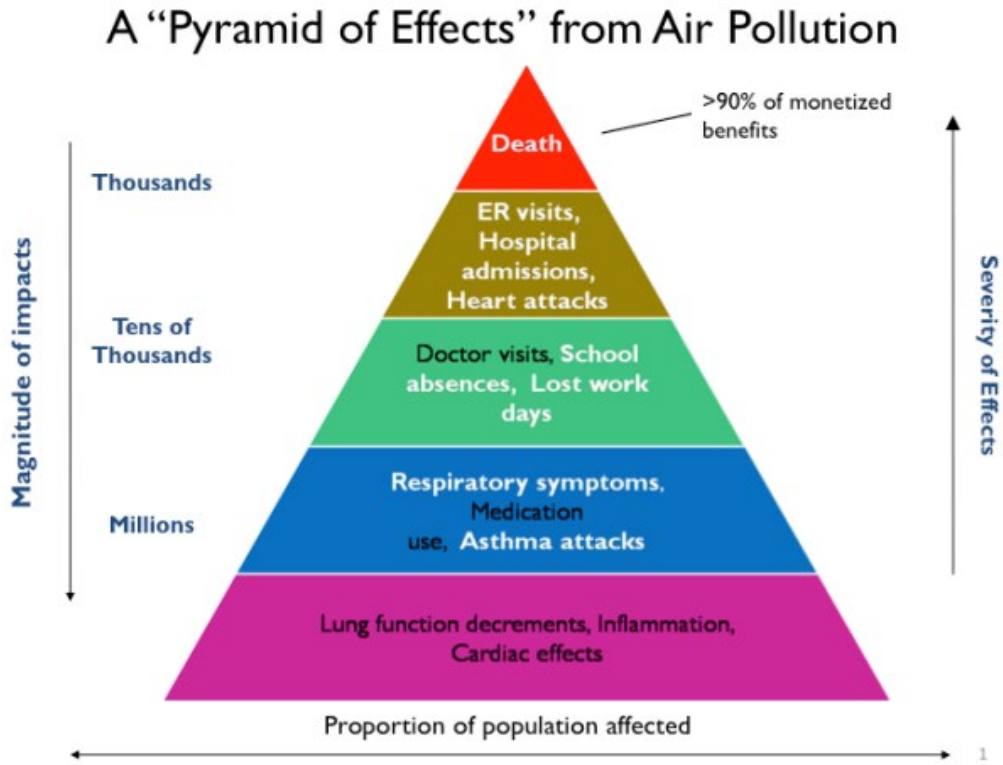


Inputs:
Local census data
- total population
- population by age

Estimates of pollution reduction

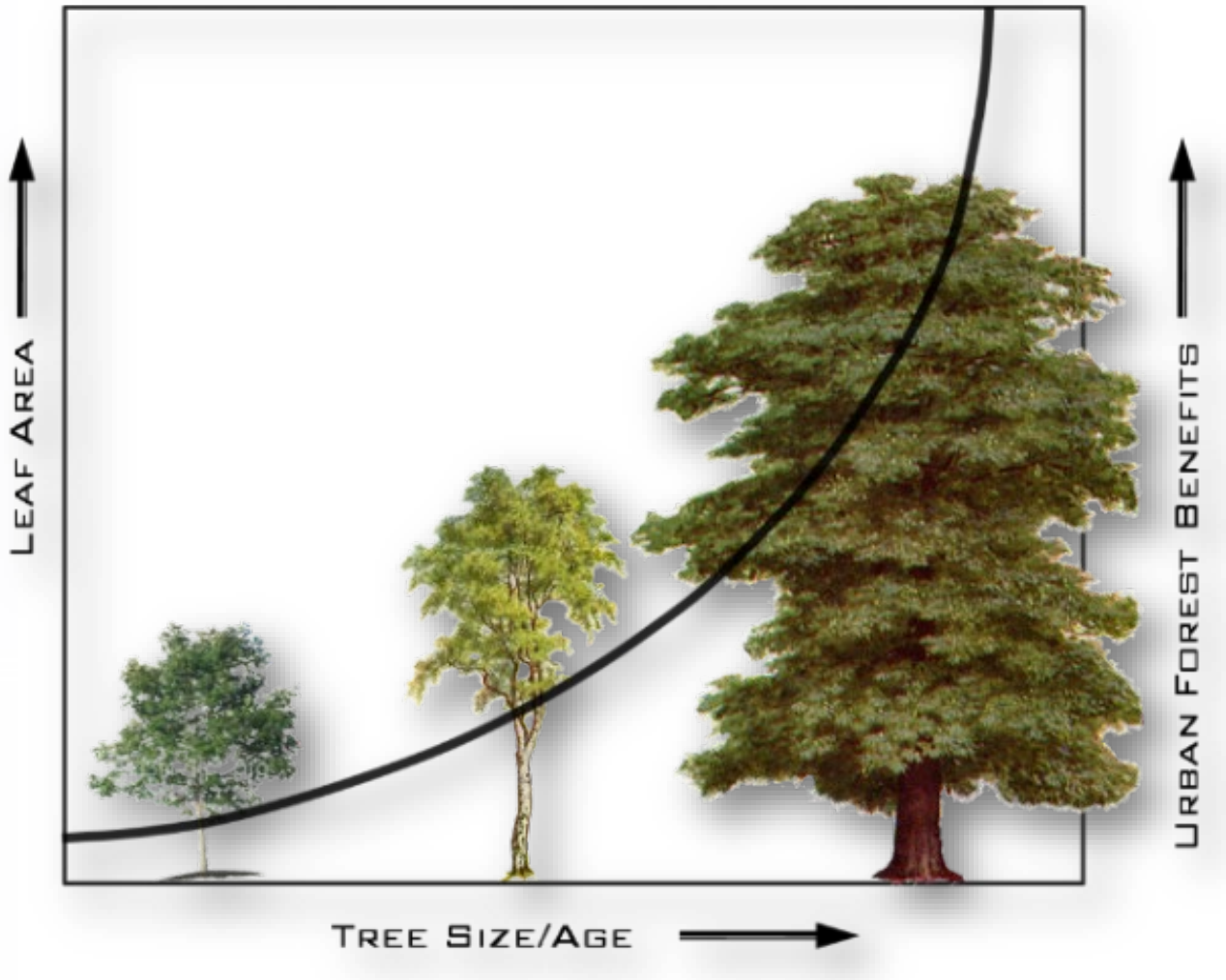
Grand rapids pollution removal value

	PM2.5 Incidence (Reduction/yr)	Value ($/yr)
Acute Bronchitis	0.206	18.12
Acute Myocardial Infarction	0.051	4,543.25
Acute Respiratory Symptoms	112.666	11,043.29
Asthma Exacerbation	88.133	7,164.56
Chronic Bronchitis	0.086	24,042.76
Emergency Room Visits	0.134	55.73
Hospital Admissions		
Hospital Admissions, Cardiovascular	0.030	1,164.32
Hospital Admissions, Respiratory	0.026	821.49
Lower Respiratory Symptoms	2.486	129.08
Mortality	0.285	2,214,131.18
School Loss Days		
Upper Respiratory Symptoms	2.048	91.95
Work Loss Days	19.238	3,298.60
Total	**225.389**	**2,266,504.33**



Key points about the science of i-Tree

- Based on research from over a dozen different researchers
- Researchers associated with half a dozen different organizations
- Research is continuously updated
- Estimates are generally conservative



Understanding i-Tree

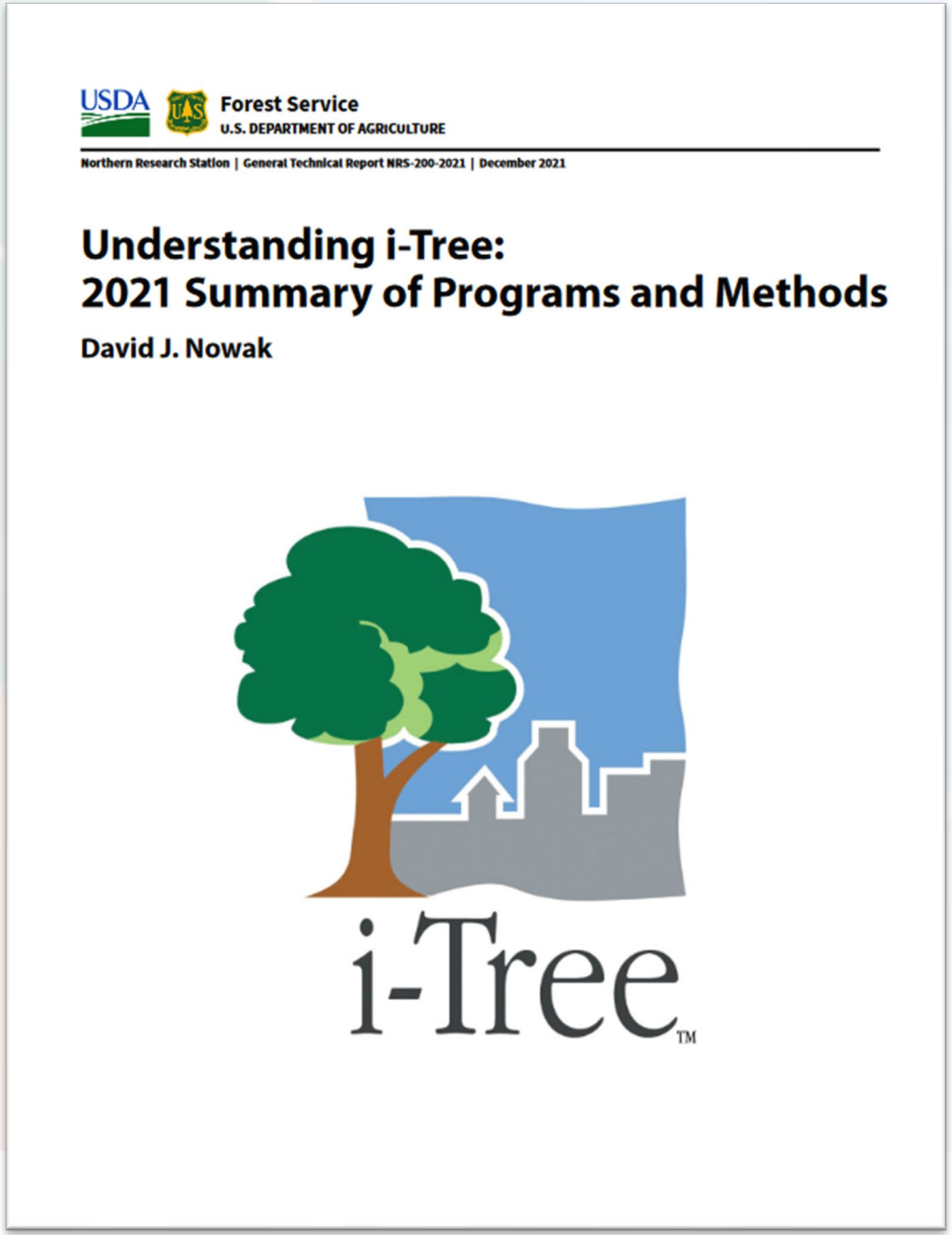


Table 2.—Summary of which directly field-measured characteristics are used to estimate derived variables and ecosystem services. D= directly used; I= indirectly used; C= conditionally used.

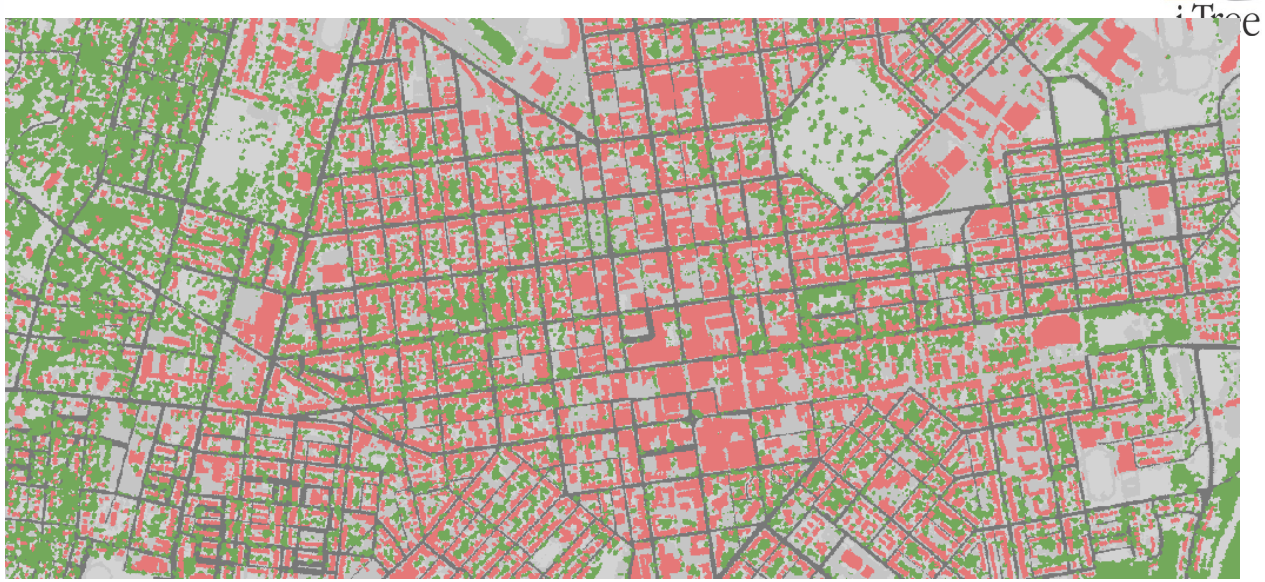
	DERIVED VARIABLES		ECOSYSTEM SERVICES										
DIRECT MEASURES	Leaf Area	Leaf Biomass	Carbon Storage	Gross Carbon Sequestration	Net Carbon Sequestration	Energy Effects	Air Pollution Removal	Avoided Runoff	Transpiration	VOC Emissions	Compensatory Value	Wildlife Suitability	UV Effects
Species	D	D	D	D	D	D	I	I	I	D	D		
Diameter at breast height (d.b.h.)			D	D	D						D	D	
Total height	D	D	C	C	C	D	I	I	I	I		D	
Crown base height	D	D	C				I	I	I	I			
Crown width	D	D	C				I	I	I	I			
Crown light exposure			C	D	D								
Percent crown missing	D	D	C	C	C	D	I	I	I	I			
Crown health (condition/ dieback)				D	D						D	D	
Field land use				D							D	D	
Distance to building						D							
Direction to building						D							
Percent tree cover						D	D	D				D	D
Percent shrub cover							D					D	
Percent building cover						D							
Ground cover composition							I					D	

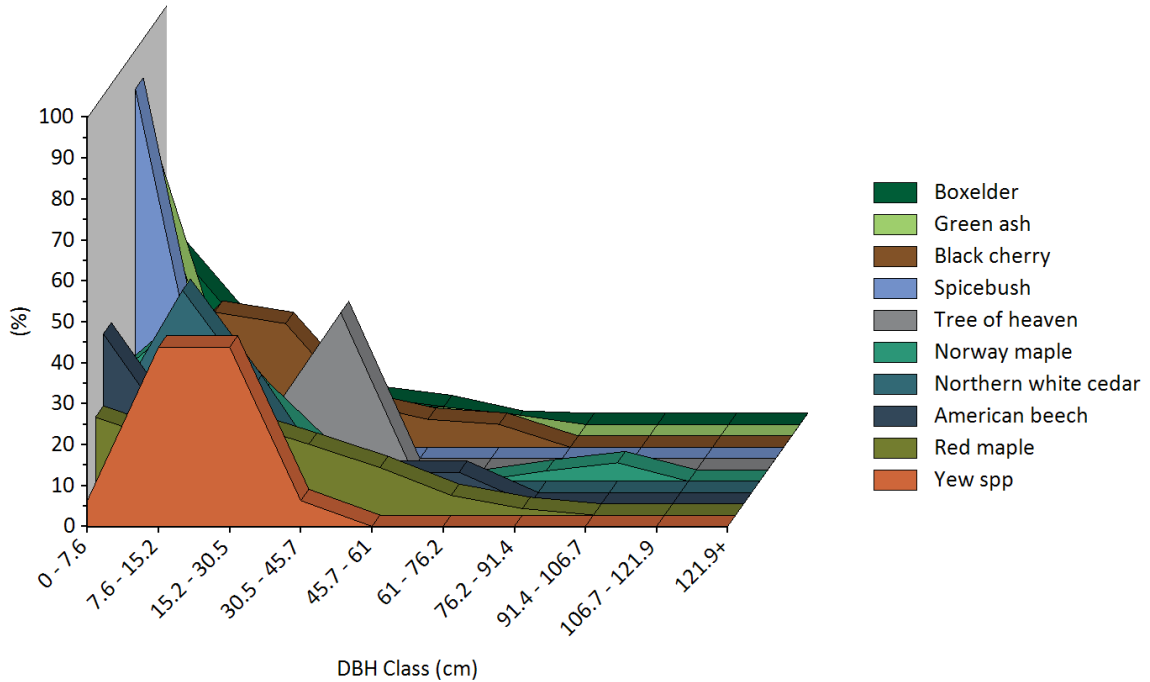
https://www.fs.usda.gov/research/treesearch/63636

Opportunities for communities

If you can't measure it, you can't manage it.

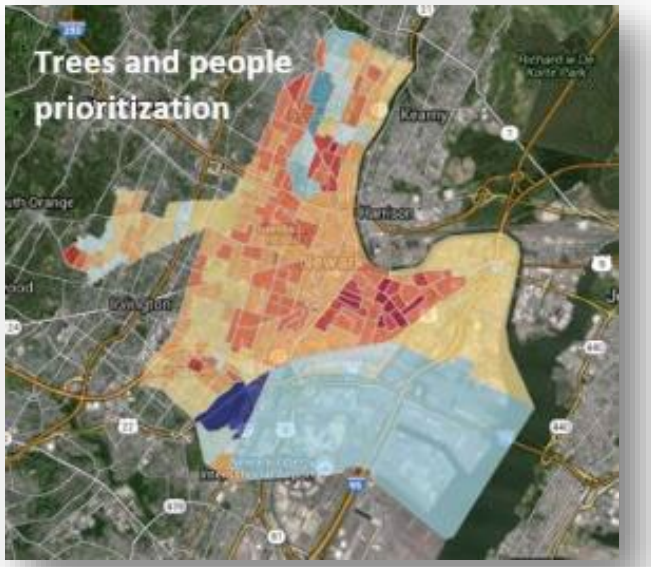
- **Map your canopy:** Knowing how tree distribution aligns with demographics can help managers maximize equity
- **Species Diversity/Composition:** Diversity reduces environmental threats, increases resilience
- **Size/Age Class Distribution:** Distribution of age informs sustainability



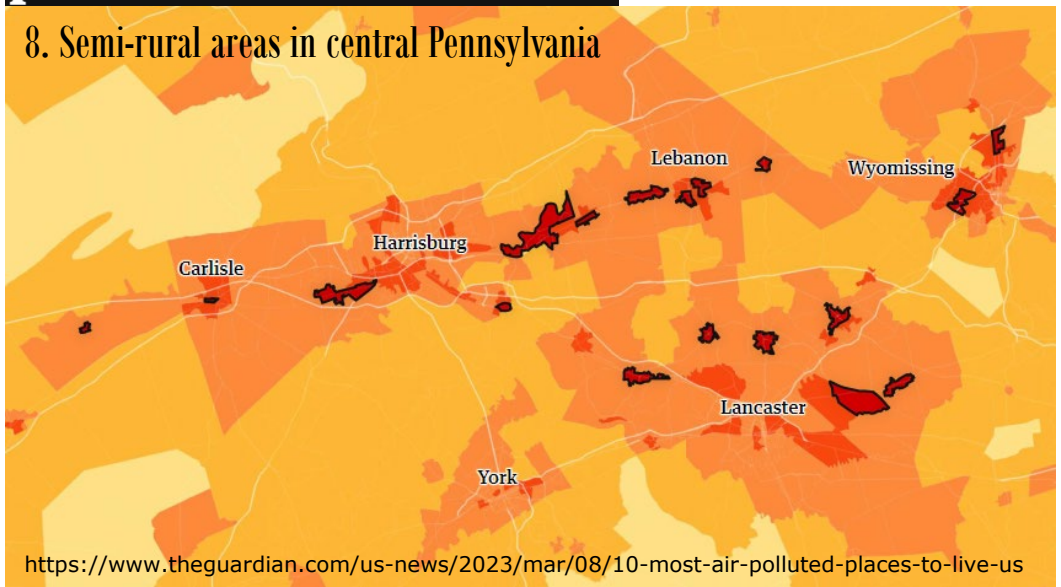


Opportunities for Communities…

- Integrate urban forests in policies: sustainability, equity, climate, resiliency, air quality, public health, stormwater
- Plan and manage urban forest resources more strategically to serve and protect citizens
- Advocate with data
- Improve preservation & health of trees and forests
- Connect urban and rural forest importance



Revealed: the 10 worst places to live in US for air pollution



https://www.theguardian.com/us-news/2023/mar/08/10-most-air-polluted-places-to-live-us

Opportunities for Communities…

- Economic opportunities: attract & retain new businesses and residents
- Promote green tourism and investment
- Create green industry jobs
- Sustainable development
- Youth education & community engagement
- Develop new relationships & partnerships…

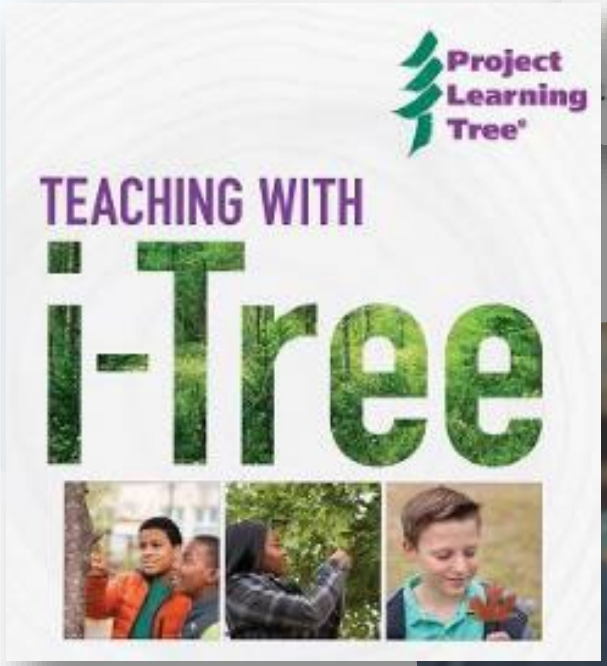


Photo credit – Jenni Garden

"These six trees store 14,291 lbs of carbon and continue to sequester 470 lbs of carbon each year. For comparison, the 1,316 small trees between 1-4 inches DBH in this study store a combined total of 16,567 lbs of carbon"

From Corey Bassett, https://www.itreetools.org/documents/352/UPenn_iTreeEcoInventory.pdf

Keys to using i-Tree effectively

- Define objectives *(what does success look like?)*
- Understand tool advantages, limitations, and options available
- Can i-Tree help you achieve desired outcomes?
- Evaluate your resources (*time, equipment, money, technical capacity, potential collaborators*) to plan, manage and complete a project.
- Consider pilot projects that can be used to learn, show potential, and justify scaling up projects.
- Connect data and results to things that matter to people

There are lots of resources to help

www.itreetools.org

Videos

Documentation

Online tools

Support

Examples

Downloads

Newsletters

Webinars

info@itreetools.org