Summer 2023 – i-Tree Open Academy
Session 1: **Introduction to i-Tree**
Understanding the benefits of trees for people, places, and planning

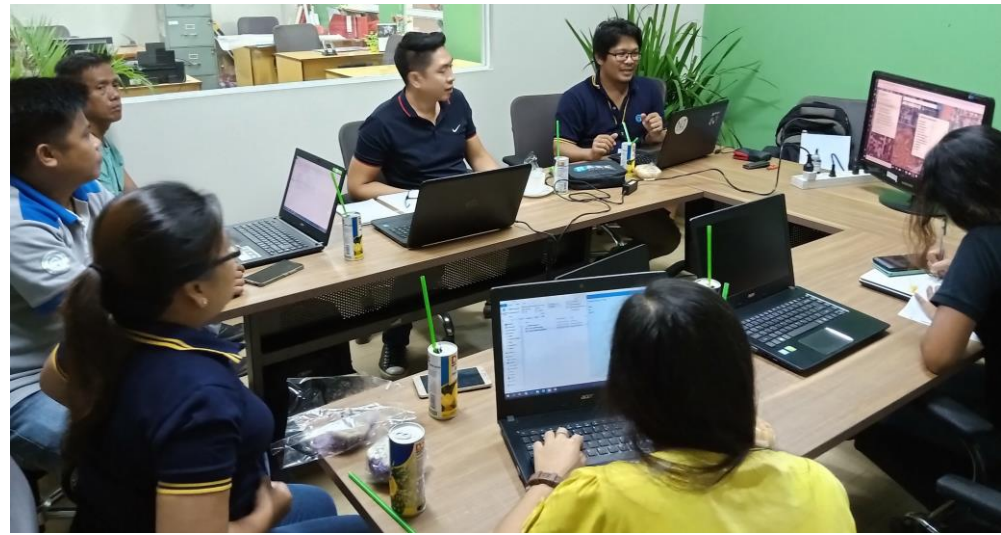*Jason Henning*

Krista Heinlin

Dave Bloniarz

Jay Heppler

Eric Greenfield

Ana Castillo

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. MyTree Demo and 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 delivers current, peer-reviewed tree benefits estimation science from the USDA Forest Service to all types of users with free tools and support.

The trees around you:

remove hazardous pollutants from the air you breathe,

absorb carbon dioxide from the air to store as wood,

and **control storm water** by intercepting and absorbing rainfall.

Trees provide more than just beauty and shade.

They work hard for all of us, every day!

Click here to learn more.

Tools for assessing individual trees

MyTree
Are you new to i-Tree? Start with our EASIEST tool! MyTree helps you quickly assess **individual trees** with a minimum of fuss.
web browser or *Android* | *Apple* devices; *Learn How to use it!*

i-Tree Design
A full-featured web tool with expanded building interactions and forecasting for estimating the benefits of **individual trees**.
via your web browser; Learn How to use it!

i-Tree Eco
Eco is our flagship tool that accommodates tree inventory IMPORT or field data evaluation to derive **individual tree** benefit estimates.
requires installation on a Windows PC; Learn How to use it!

Tree canopy area assessment tools

OurTrees
Beta release: Quick **tree canopy** and related information for your community within the continental US!
web browser or *Android* | *Apple* devices

i-Tree Landscape
US **tree canopy** and Census maps/data at your fingertips! Identify priority planting & protection areas for climate & social issues.
via your web browser; Learn How to use it!

i-Tree is a Cooperative Initiative — FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE | DAVEY | Arbor Day Foundation | sma SOCIETY OF MUNICIPAL ARBORISTS | ISA International Society of Arboriculture | Casey Trees WASHINGTON DC | 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.*

Milwaukee's Trees
Help Us Breathe Easier
Think about it...

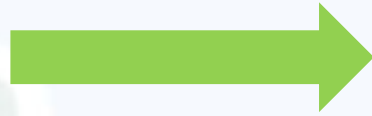City of Adelaide
Photo credit Jenni Garden

The i-Tree Framework: Demonstrating tree value

Structure → **Function** → **Value**
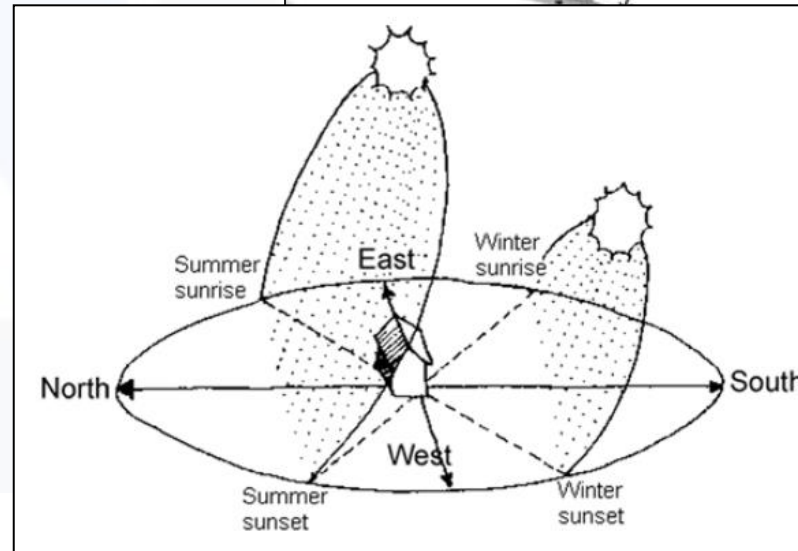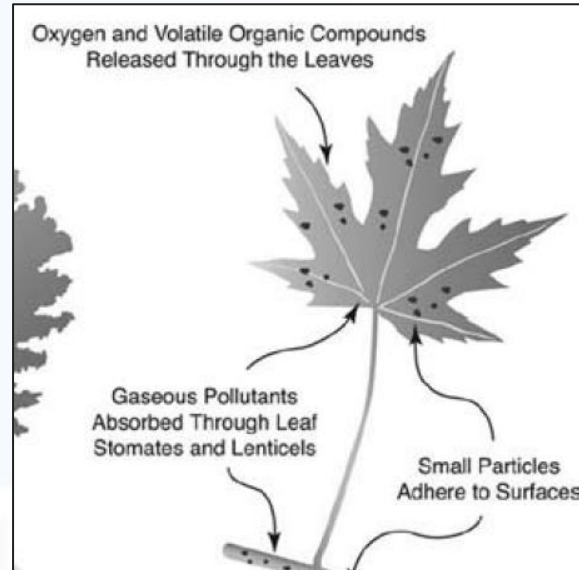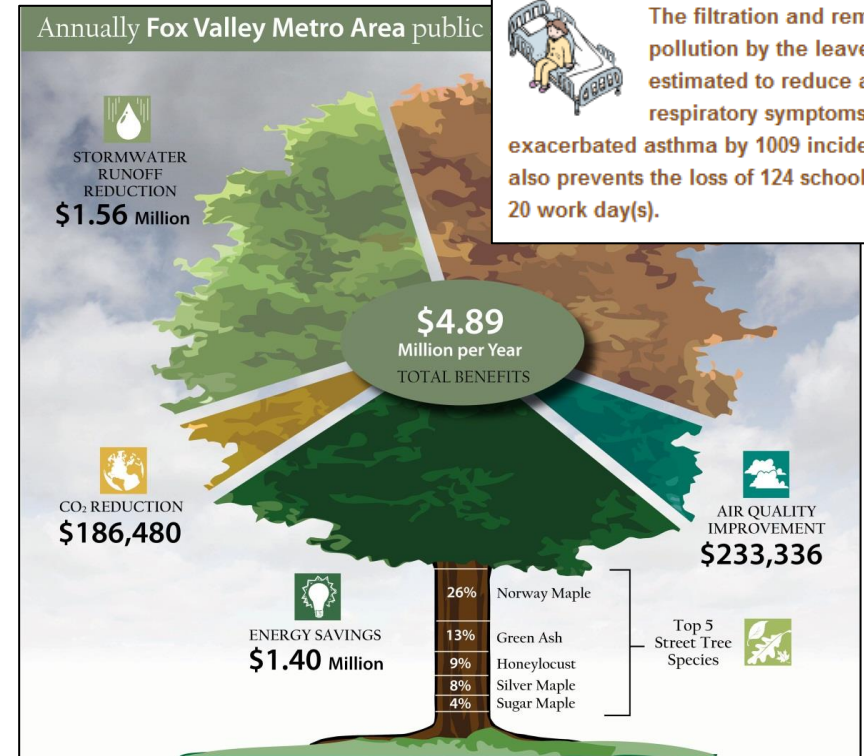
What does i-Tree Estimate and Why?
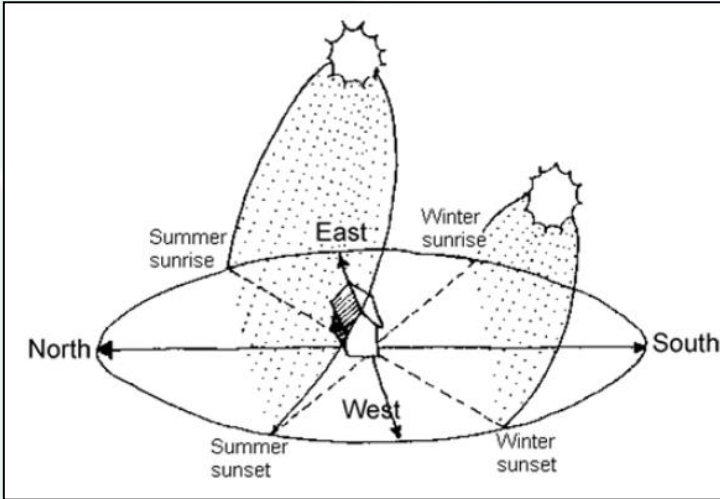
Energy
Tree impacts on
heating and cooling
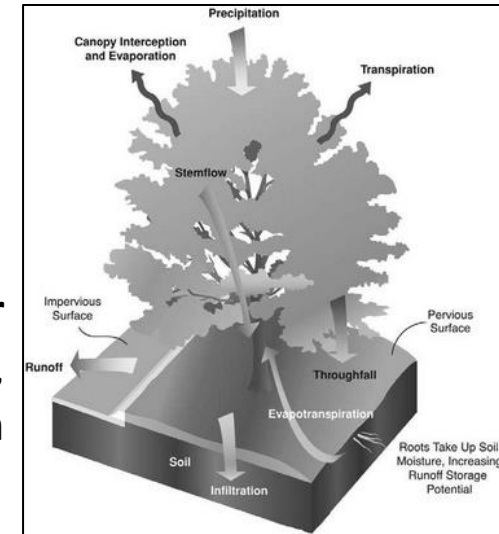
Stormwater
Avoided runoff,
evaporation, transpiration

Carbon dioxide
Storage and sequestration
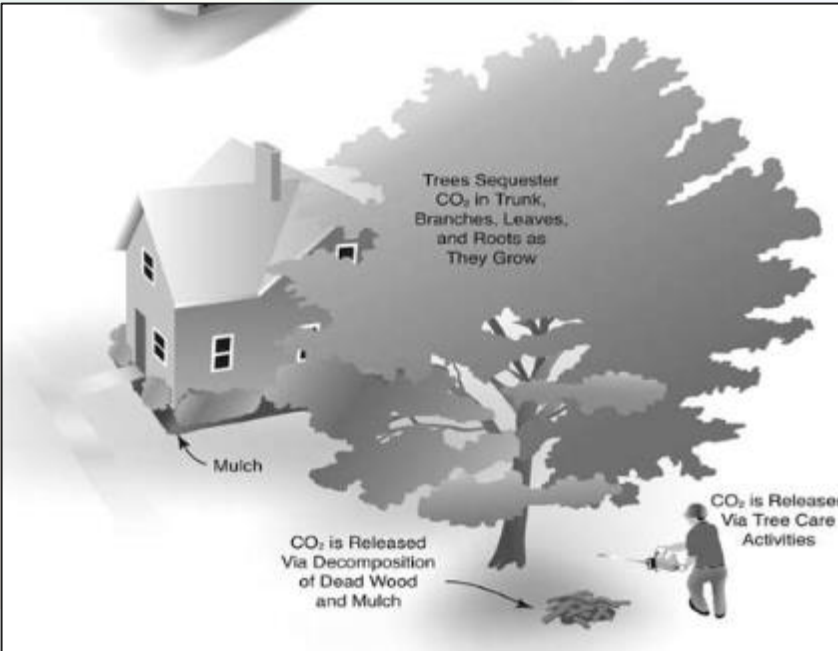of a greenhouse gas
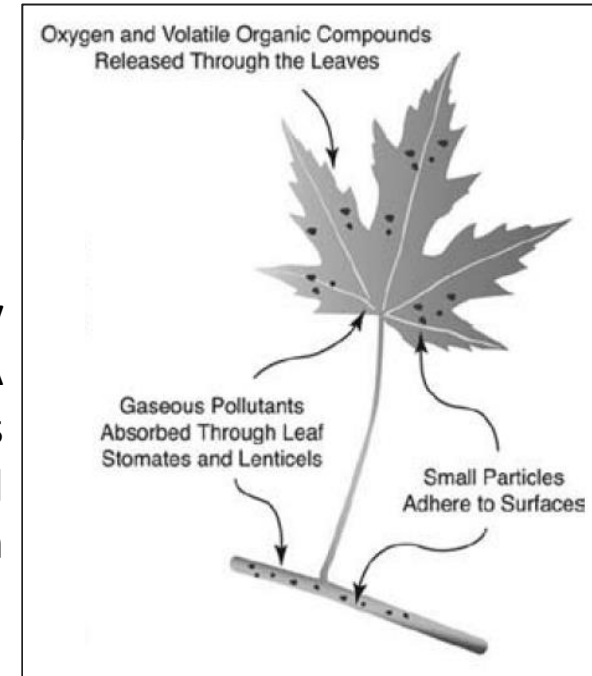
Air Quality
Interaction with EPA
criterion pollutants
resulting in improved
health

The 2023 i-Tree Suite of Tools

Core individual tree tools

MyTree   Planting   Design

Core canopy tools

OurTrees   Canopy   Landscape

Eco

Utilities

County   Database   Species

Research Suite   Tree Map   API

. . .

i-Tree Tools that can be used internationally

i-Tree is a Cooperative Initiative among these partners

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

Crown width

Field Data

Tree height

Crown base height

DBH
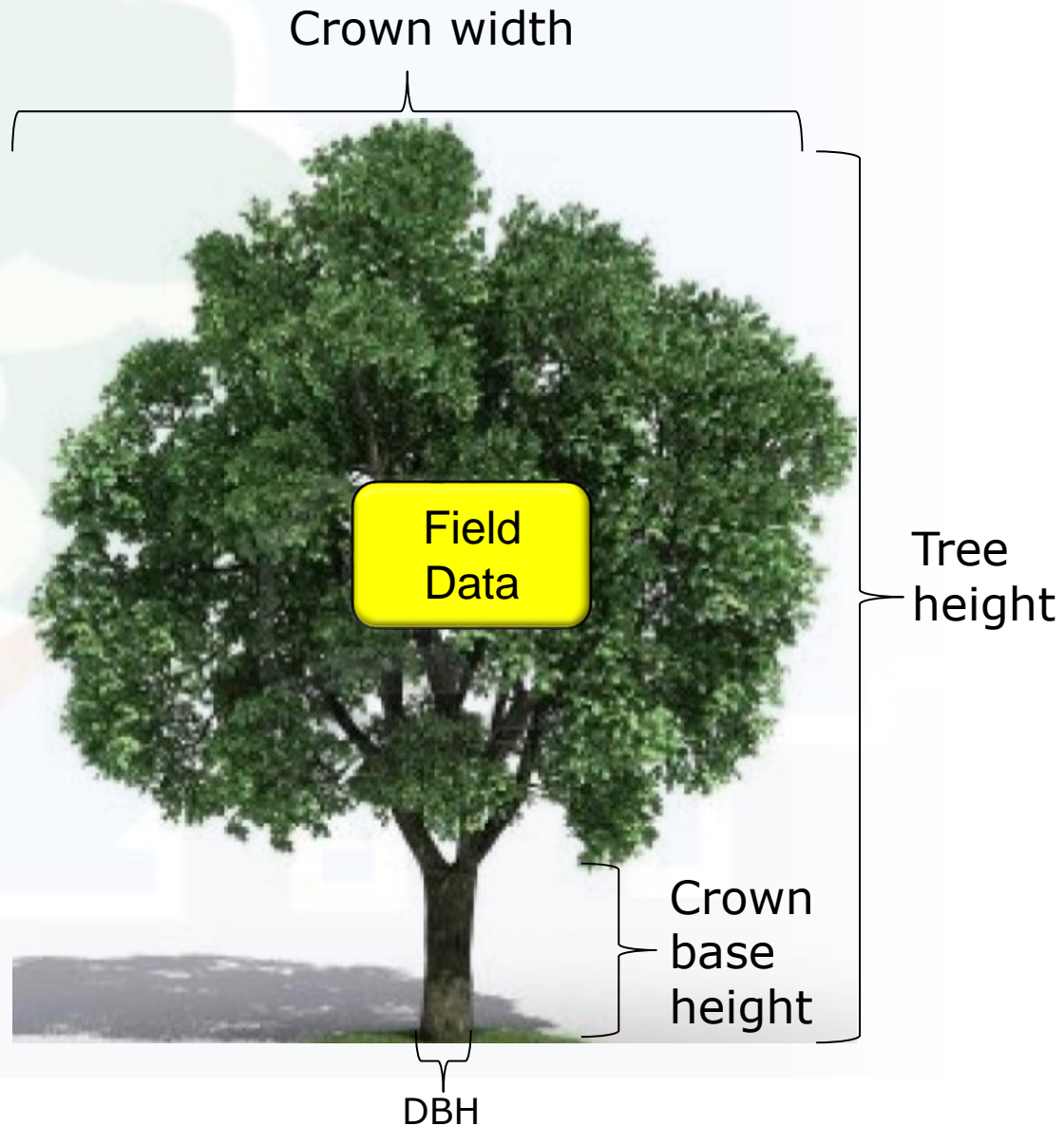
Key field variables
- **DBH**
- **Species**
- Crown measurements
- Tree health
- Building interactions
- Light availability

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

City Data

Pollution Data

Weather Data

Species Data
(*8000+*)

Location Data

Field Data

i-Tree Eco

Structure

Air Quality

Hydrology

Energy

Carbon

Value

Forecast
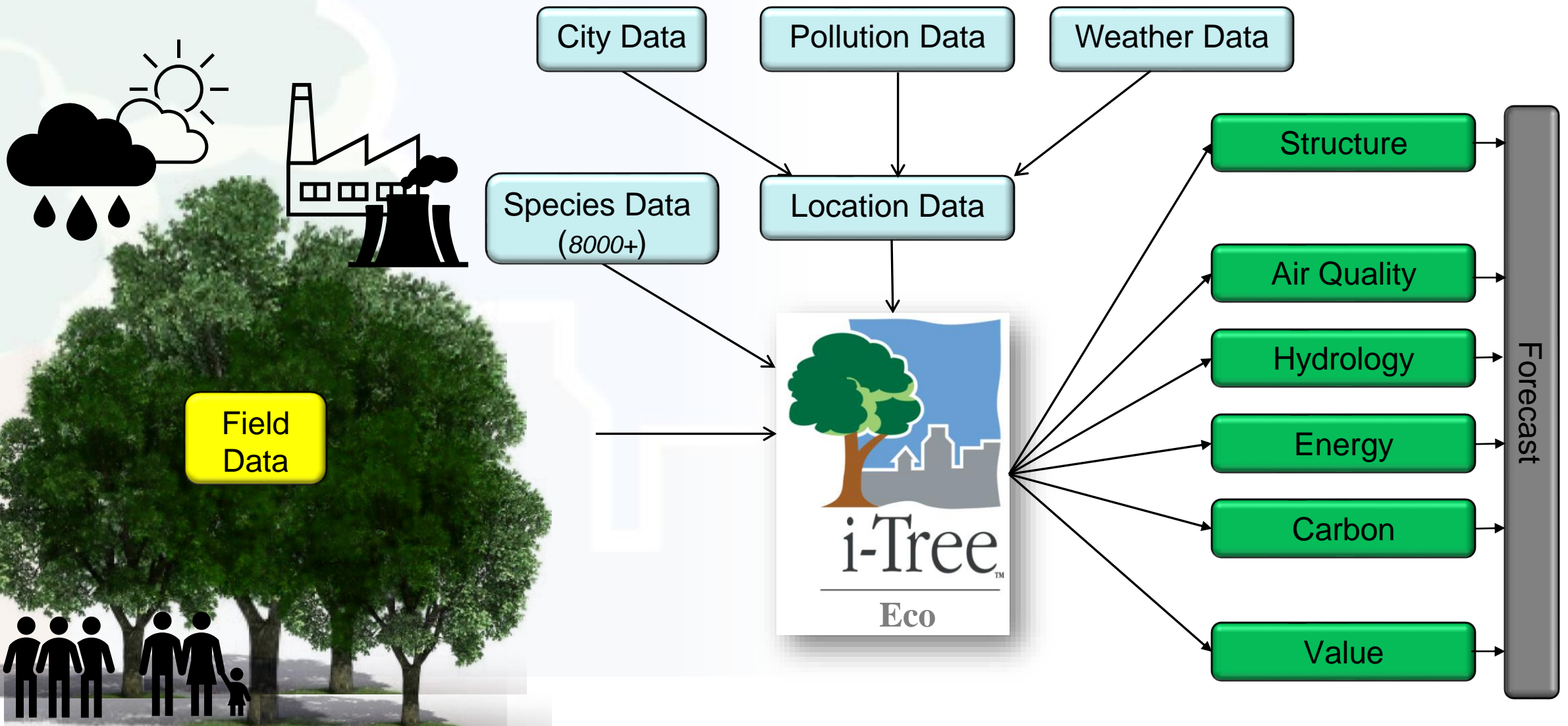
i-Tree Tool Relationships

Eco: Tree/Population Ecosystem Services Calculator

i-Tree Engine/API: Individual tree benefits and projections

MyTree

Planting

Design

Cover multipliers: Structure and benefits per unit area of tree cover

Canopy

Landscape → OurTrees

Science of i-Tree - Air pollution benefits
Step 1: Estimate tree <u>structure</u>: Leaf surface area

Canopy width

Tree height

Crown base height

DBH

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

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

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

2. With crown size measurements we can estimate crown surface
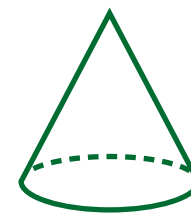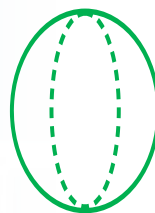
3. With crown surface we can estimate leaf surface area

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
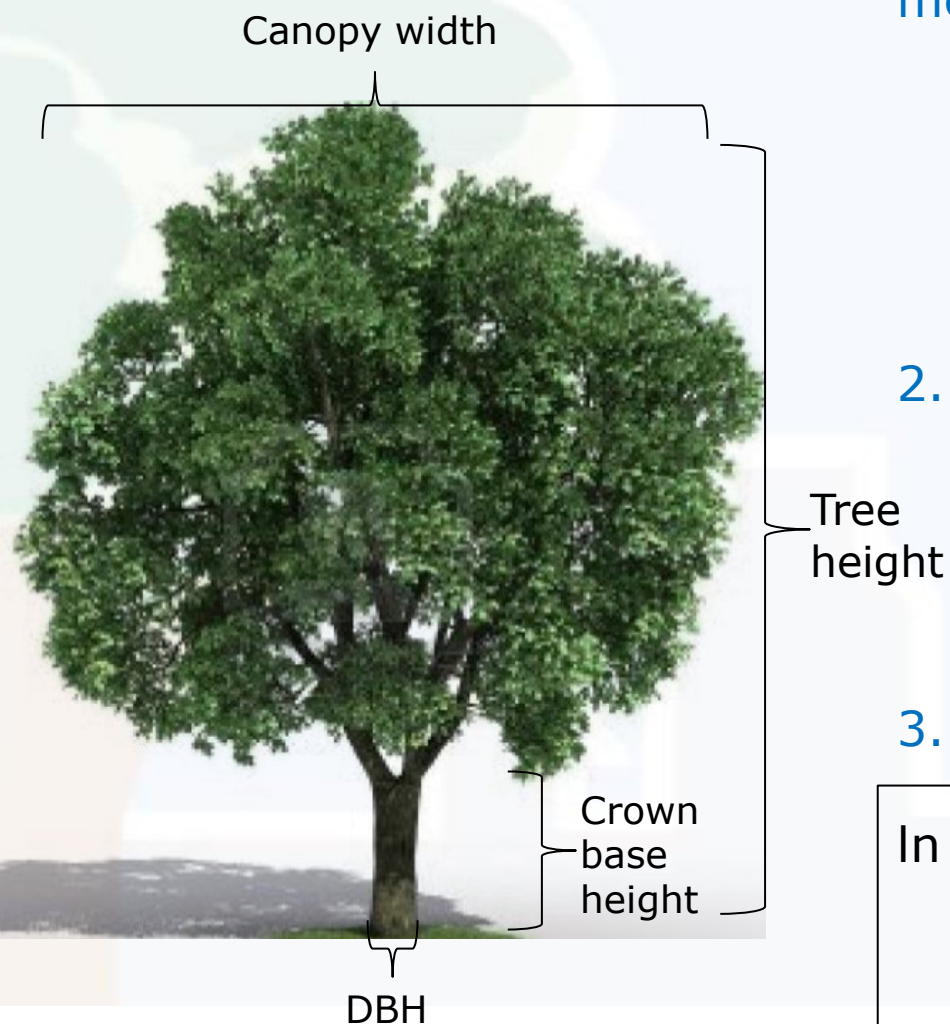
Leaf surface area of 18" dbh trees

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
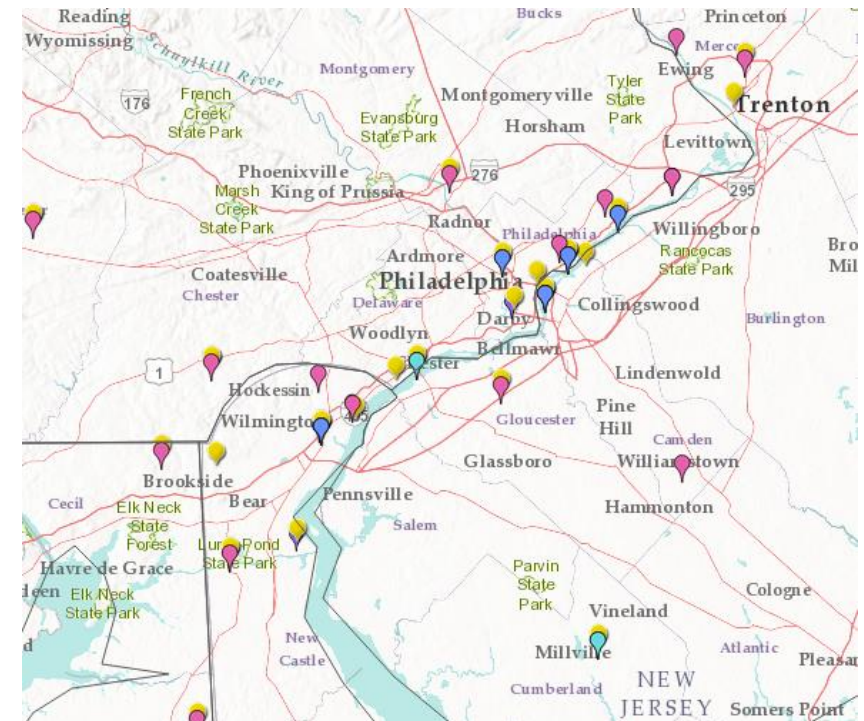
Pollution removal by trees in Grand Rapids, MI

PM2.5 Removal by Month
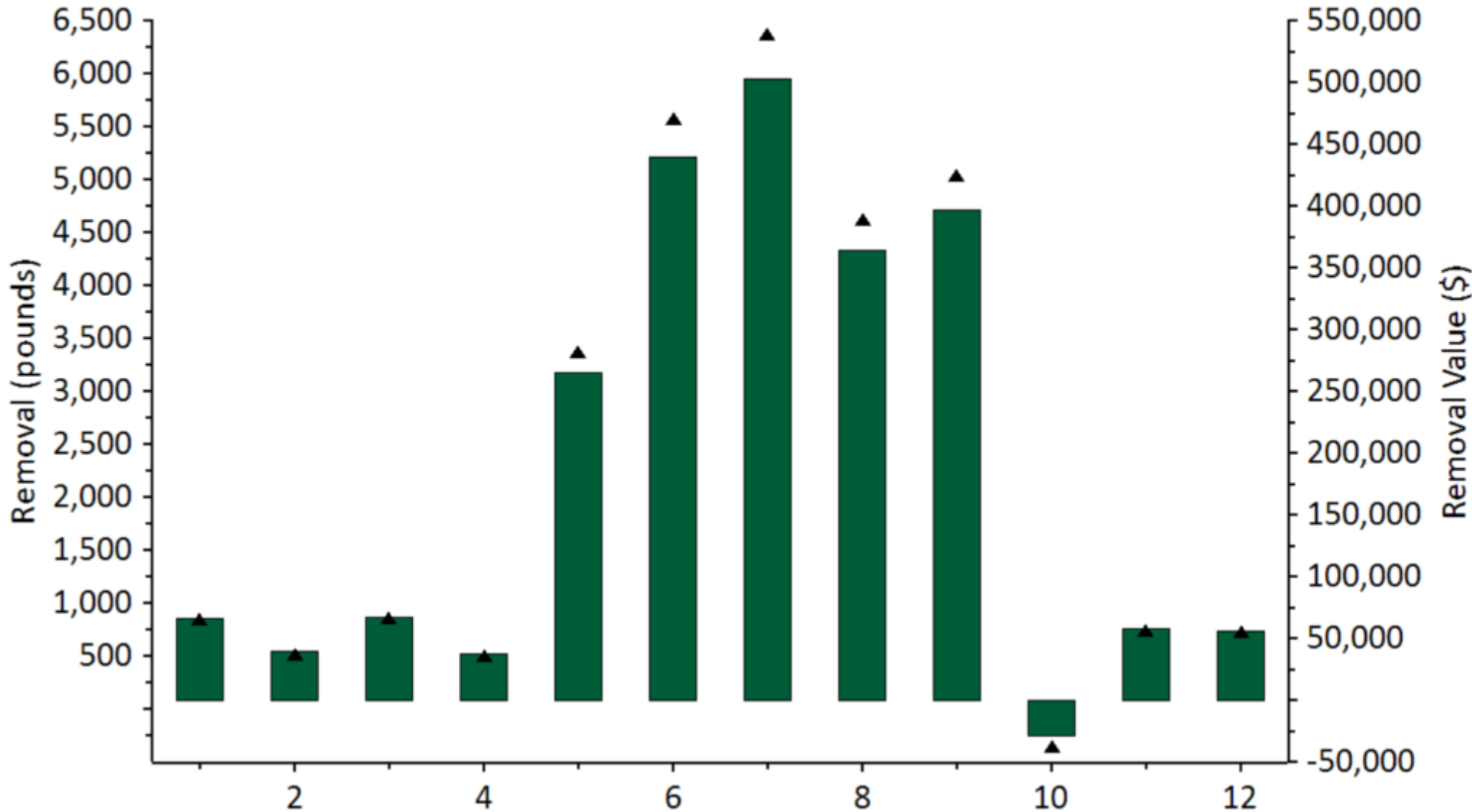
Step 3: Estimating value
Monetary value of pollution removal by trees

EPA United States Environmental Protection Agency

Benefits Mapping and analysis program (BenMAP)

$5,000/admission → $100 \cdot \$5,000 = \$500,000$

| An air quality policy reduces the number of hospital admissions by 100 | The economic value of each avoided admission is $5,000 in the year 2010 | The economic value is the number of cases multiplied by the value of each admission |

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

Estimates of pollution reduction

i-Tree

Grand Rapids, MI pollution removal value

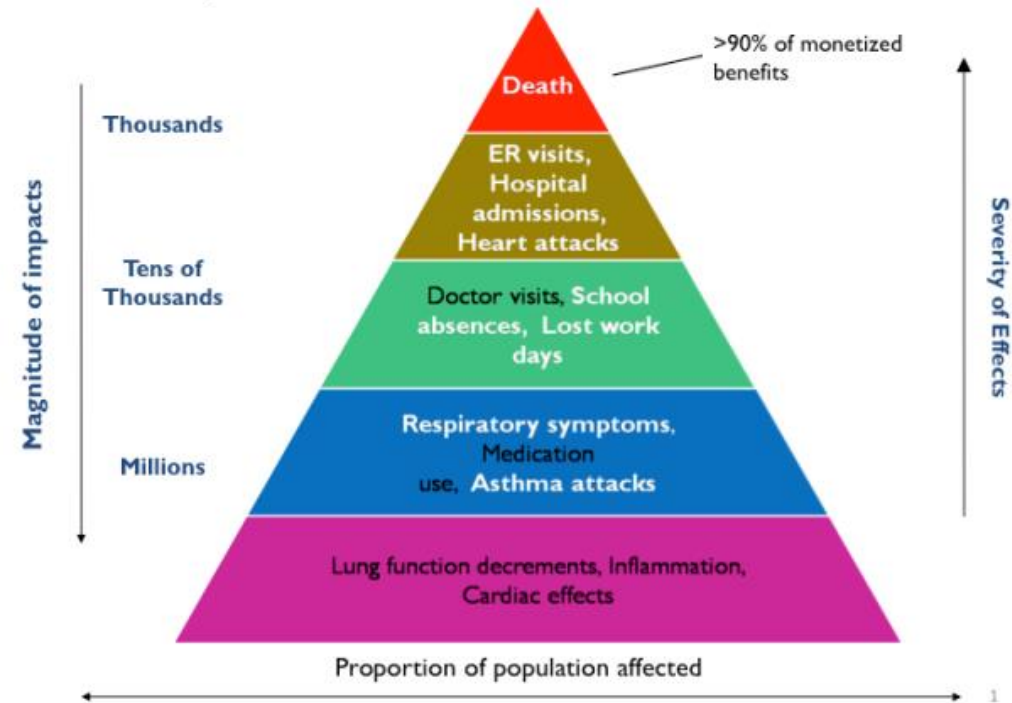|	PM2.5 Incidence (Reduction/yr)	Value ($/yr)
Acute Bronchitis	0.206	18.12
Acute Myocardial Infarction	0.051	4,543.25
Acute Respiratory Symptoms	112.666	11,043.29
Asthma Exacerbation	88.133	7,164.56
Chronic Bronchitis	0.086	24,042.76
Emergency Room Visits	0.134	55.73
Hospital Admissions		
Hospital Admissions, 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**

A "Pyramid of Effects" from Air Pollution

>90% of monetized benefits

Death

ER visits, Hospital admissions, Heart attacks

Doctor visits, School absences, Lost work days

Respiratory symptoms, Medication use, Asthma attacks

Lung function decrements, Inflammation, Cardiac effects

Thousands

Tens of Thousands

Millions

Magnitude of impacts

Severity of Effects

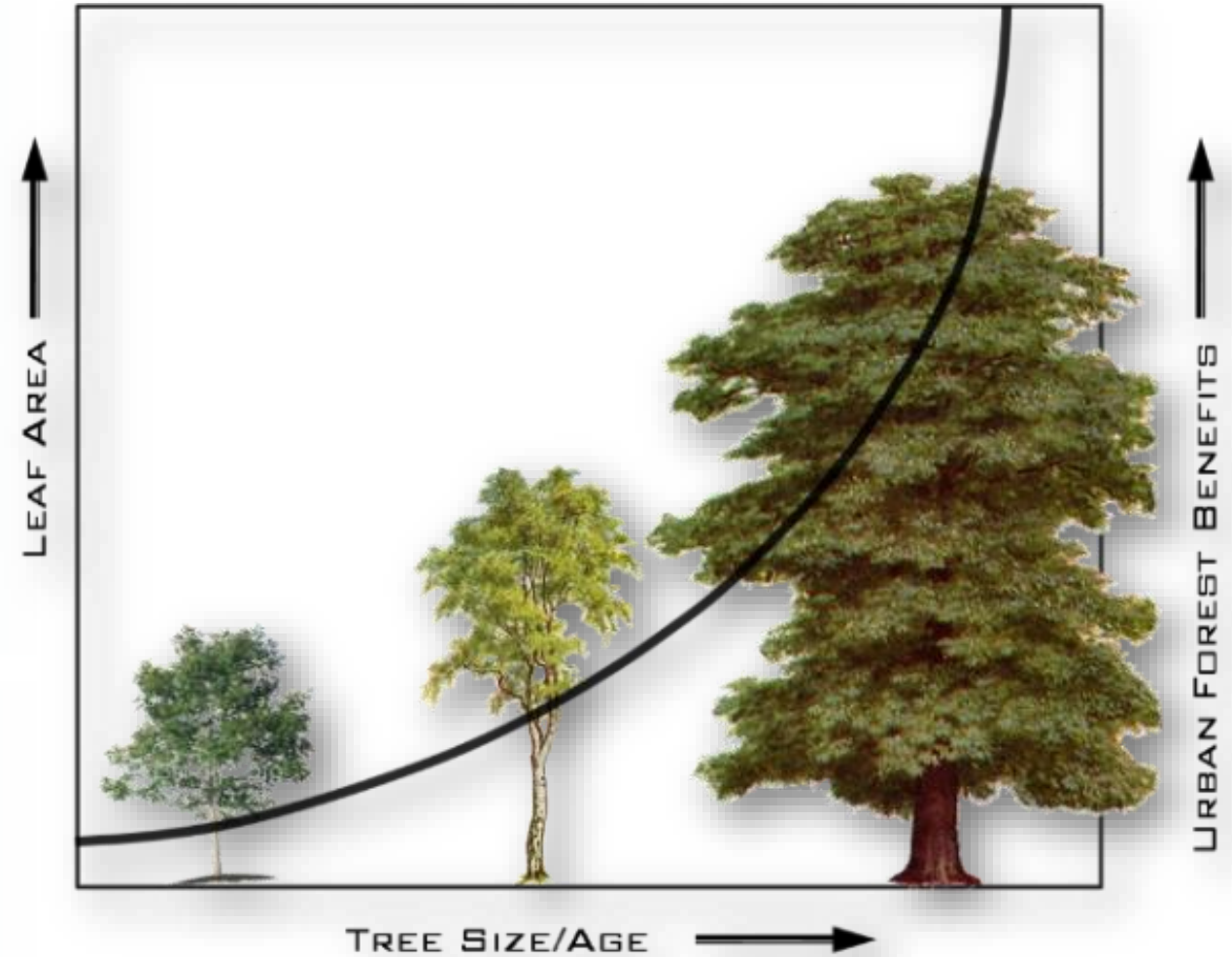Proportion of population affected

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

USDA Forest Service — U.S. DEPARTMENT OF AGRICULTURE
Northern Research Station | General Technical Report NRS-200-2021 | December 2021

**Understanding i-Tree:
2021 Summary of Programs and Methods**

David J. Nowak

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.

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

Example: i-Tree Eco Results

Number of downtown trees: 9,755

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
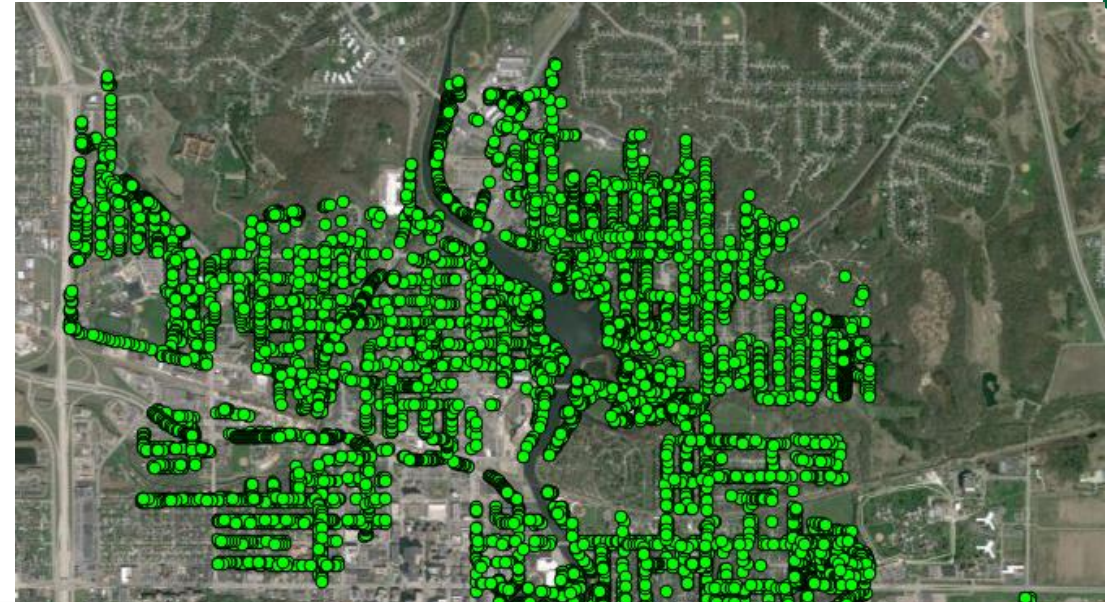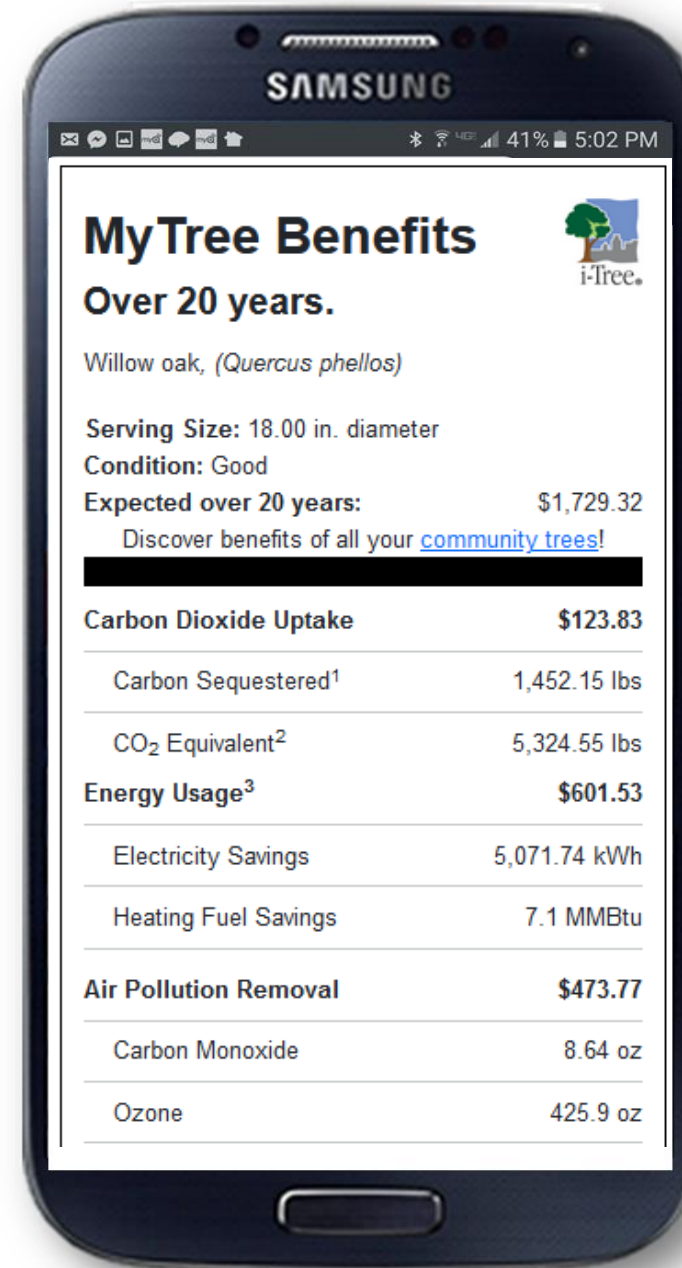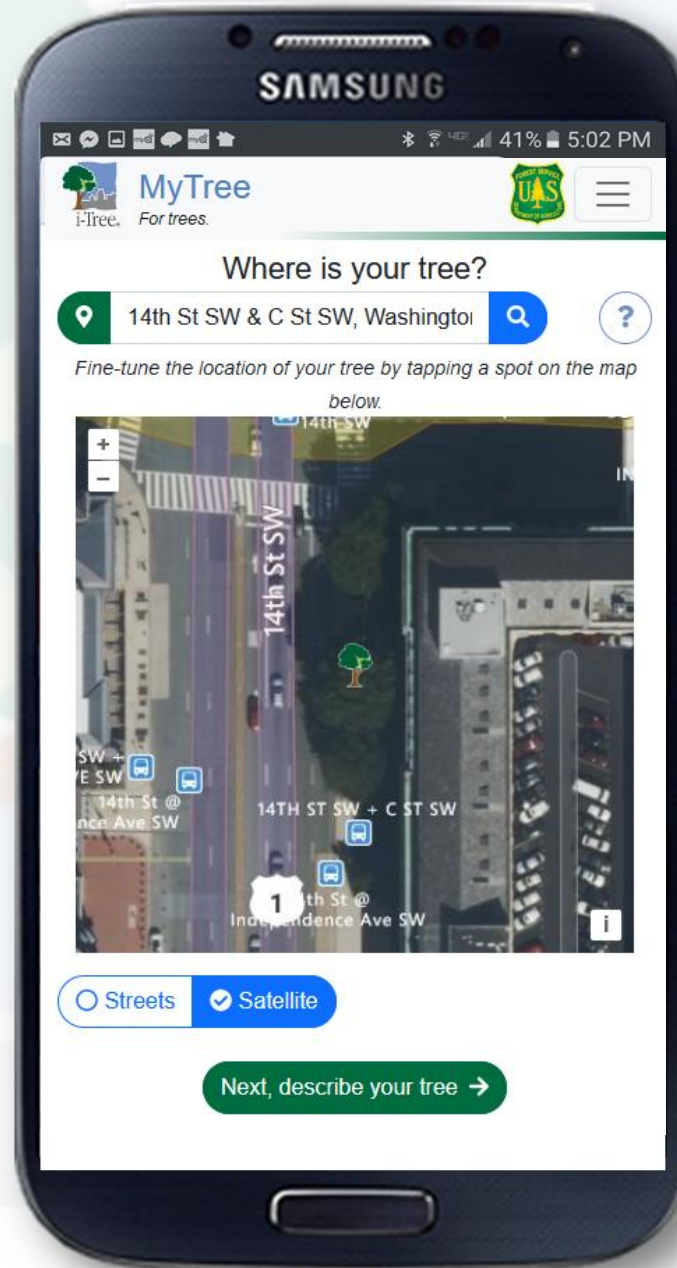 $13.4 thousand/year

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

MyTree: Making i-Tree Easy

MyTree.itreetools.org

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

Trees and people prioritization

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

8. Semi-rural areas in central Pennsylvania

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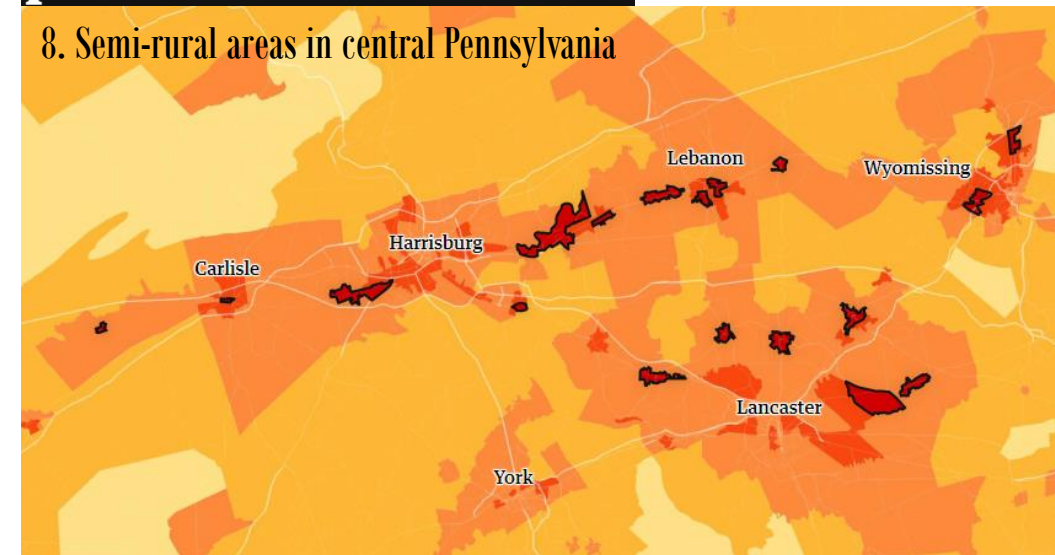
Opportunities for Communities…

- Economic opportunities: attract & retain new businesses and residents

- Promote green tourism and investment

- Create green industry jobs

- Sustainable development

- Youth education & community engagement
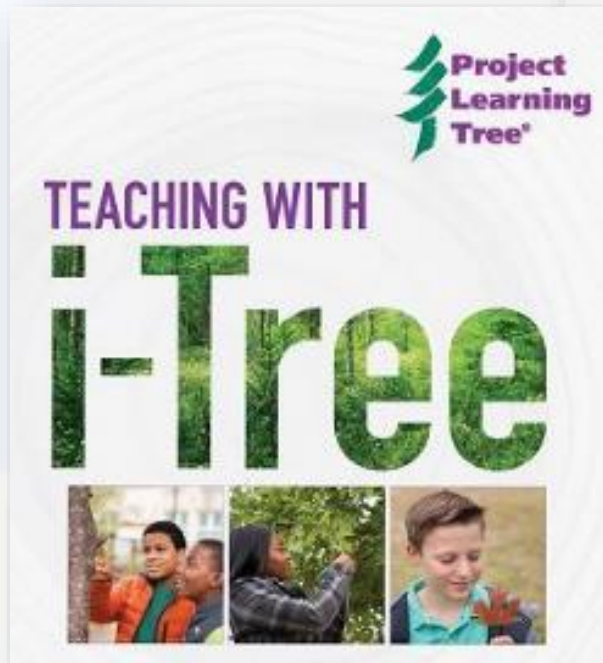
- Develop new relationships & partnerships…
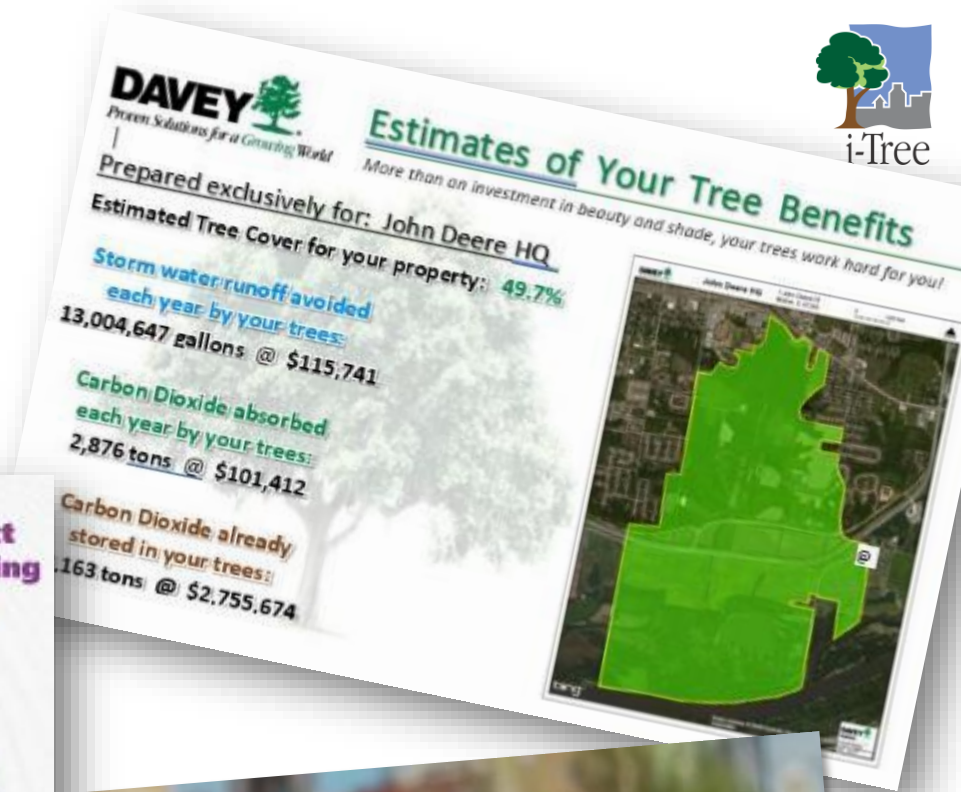

Photo credit – Jenni Garden

"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 advantages, limitations, and options available with different i-Tree tools.

- 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 issues 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