Preparing Cleveland Metroparks' Forests for Climate Change

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Cleveland Metroparks
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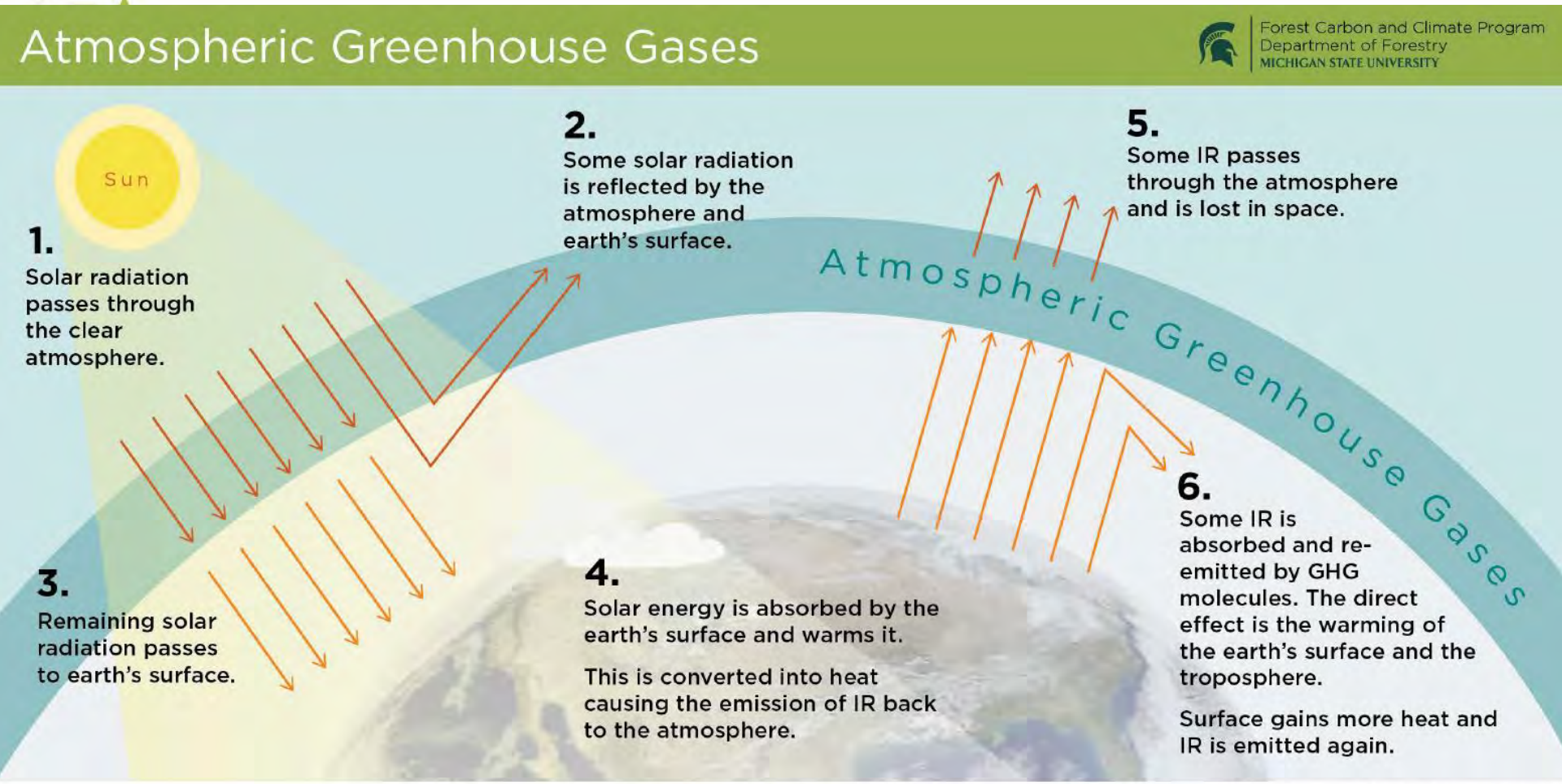
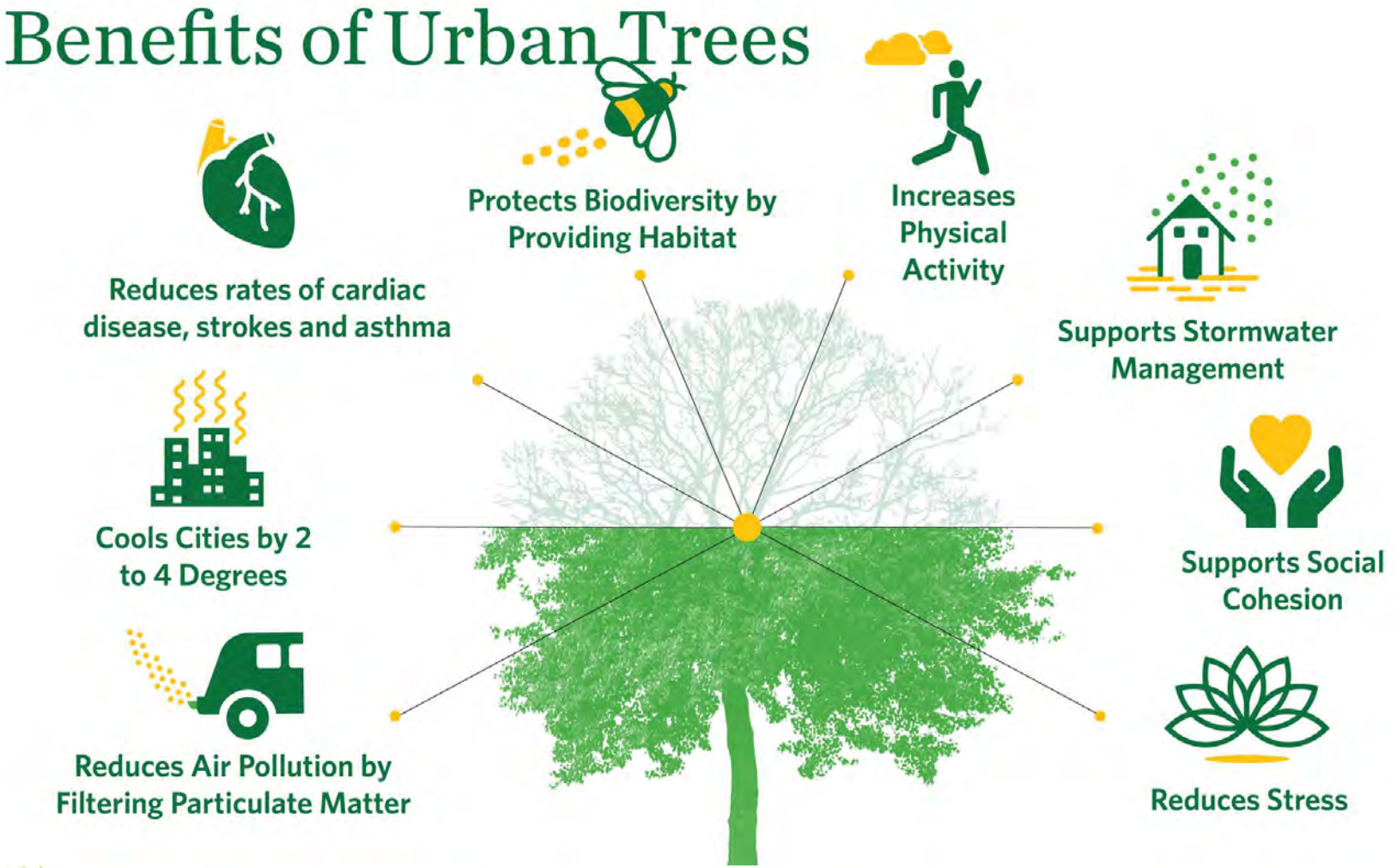
Climate Change

Climate Change



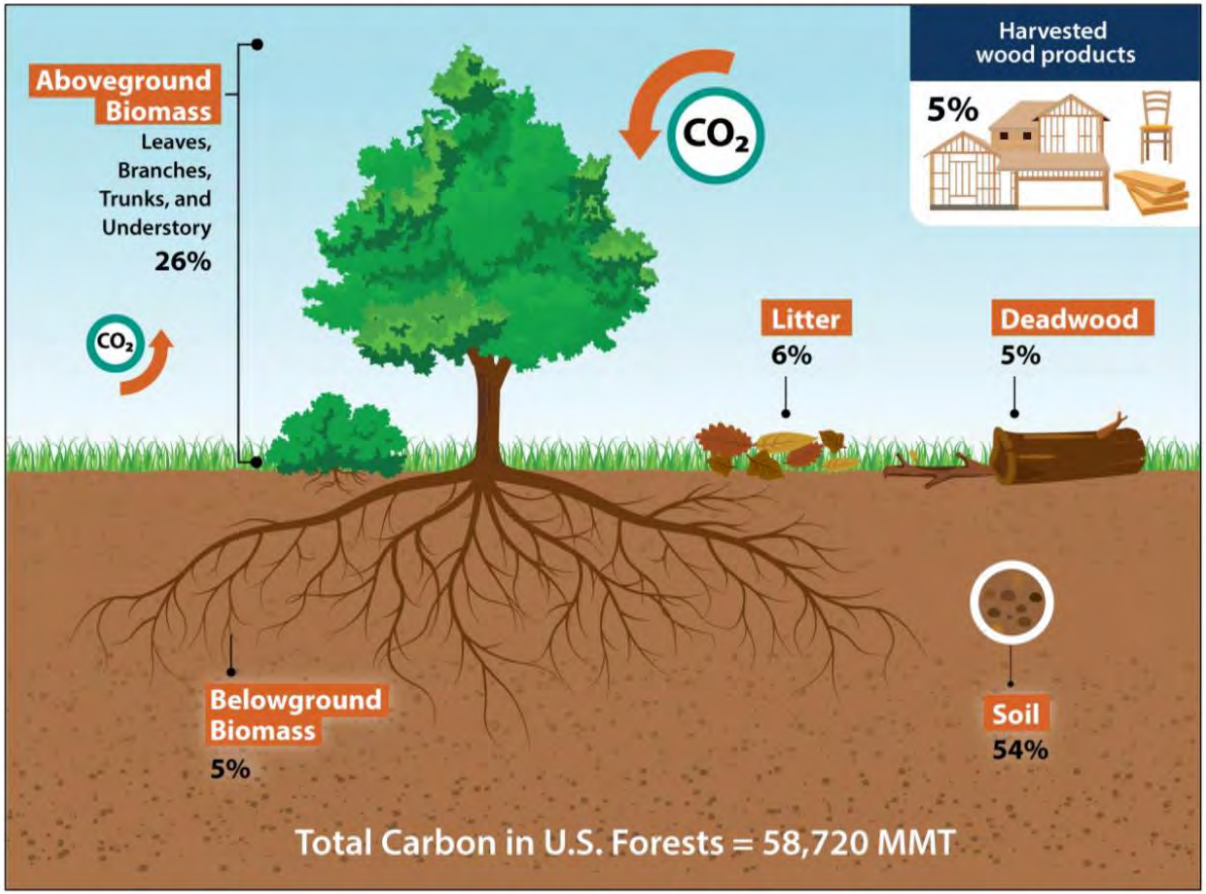
Data source: Okanangan University College in Canada, US EPA, UNEP
Image Adapted by MSU FCCP

Natural Climate Solutions



Natural Climate Solutions

Figure 2. Forest Carbon Pools



Source: CRS, using data for 2019 from EPA, Table 6-12 in Chapter 6, "Land Use, Land-Use Change, and Forestry," in *U.S. National Greenhouse Gas Inventory*, EPA 430-R-20-002, April 13, 2020.

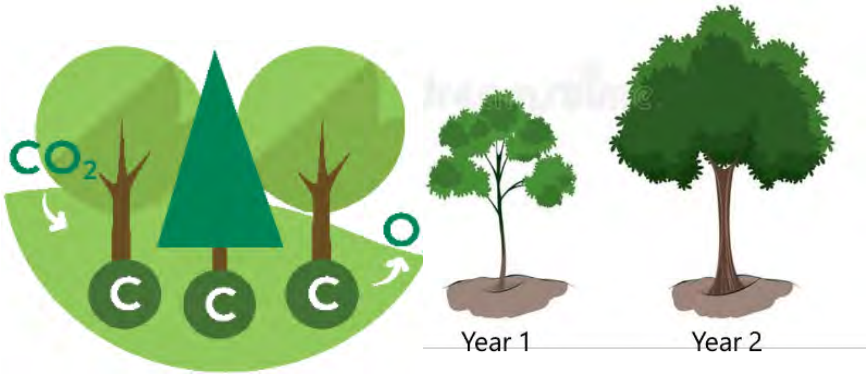
Notes: MMT = million metric tons. Percentages based on the total forest carbon stock estimate for 2019 (see **Table 3**).

Carbon storage & sequestration

Carbon storage:
Amount of total carbon in a reservoir

Units: kg C, kg CO_2e,
mt C, mt CO_2e
(per unit area)

Carbon sequestration:
Process of removing carbon from atmosphere and storing long-term



Units: kg C/year, kg CO_2e /year
(per unit area)

Climate Resilience & Carbon Management

Project Background:

The Lubrizol Foundation grant in 2021

Funded two years of project and product development

Charles L. Pack Trust grant in 2023 for supplemental funds for product development

Cleveland Metroparks FINDYOURPATH

Lubrizol

Climate Resilience & Carbon Management

Goal 1: Evaluate Cleveland Metroparks ~18,000 acres of forest to understand carbon storage and sequestration

Goal 2: Manage forests to be resilient to climate change

Step 1: Develop Carbon Accounting Reports

Step 2: Develop Forest Management Guideline

Step 3: Create Educational Resources

Cleveland Metroparks FINDYOURPATH

Lubrizol

Cleveland Metroparks

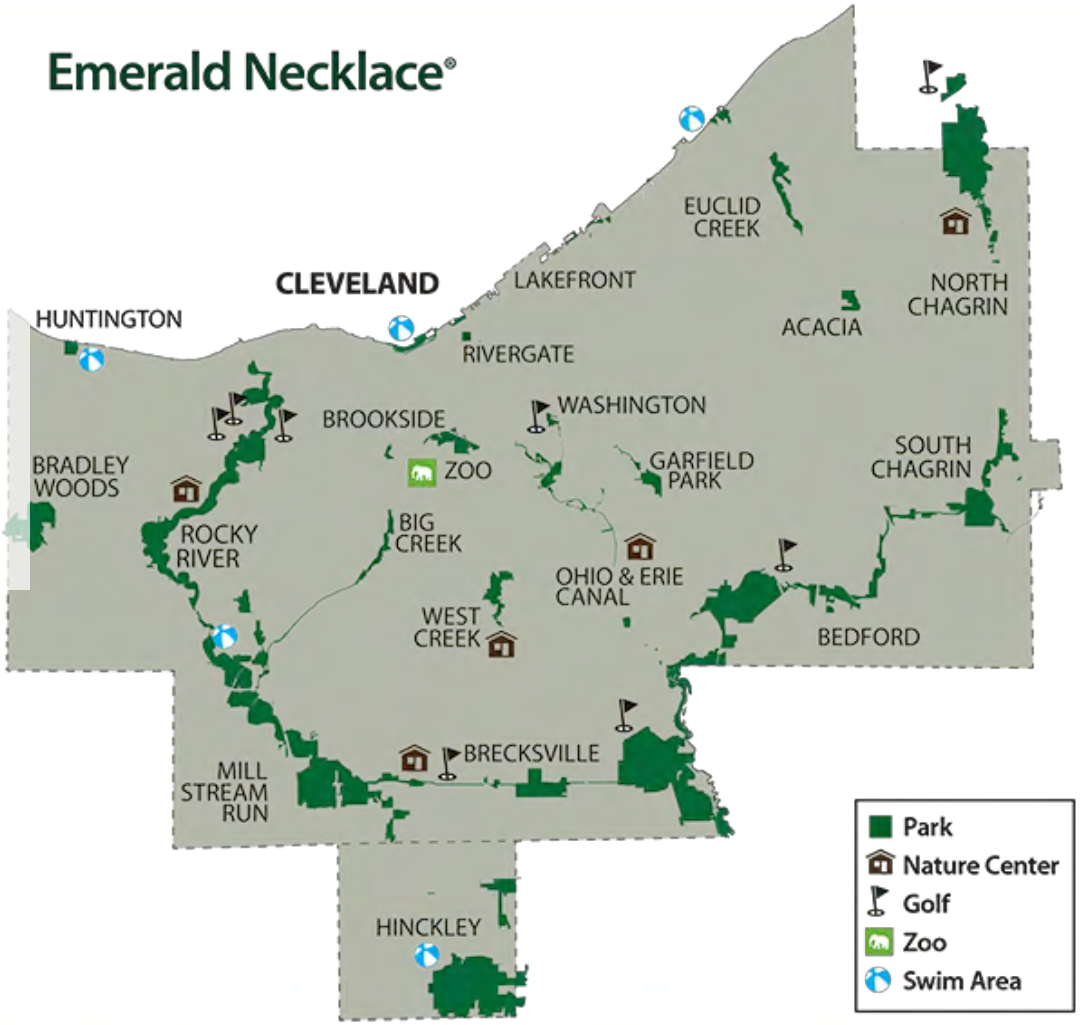
Founded in 1917

>24,000 acres (~3/4 forested, natural areas)

18 reservations

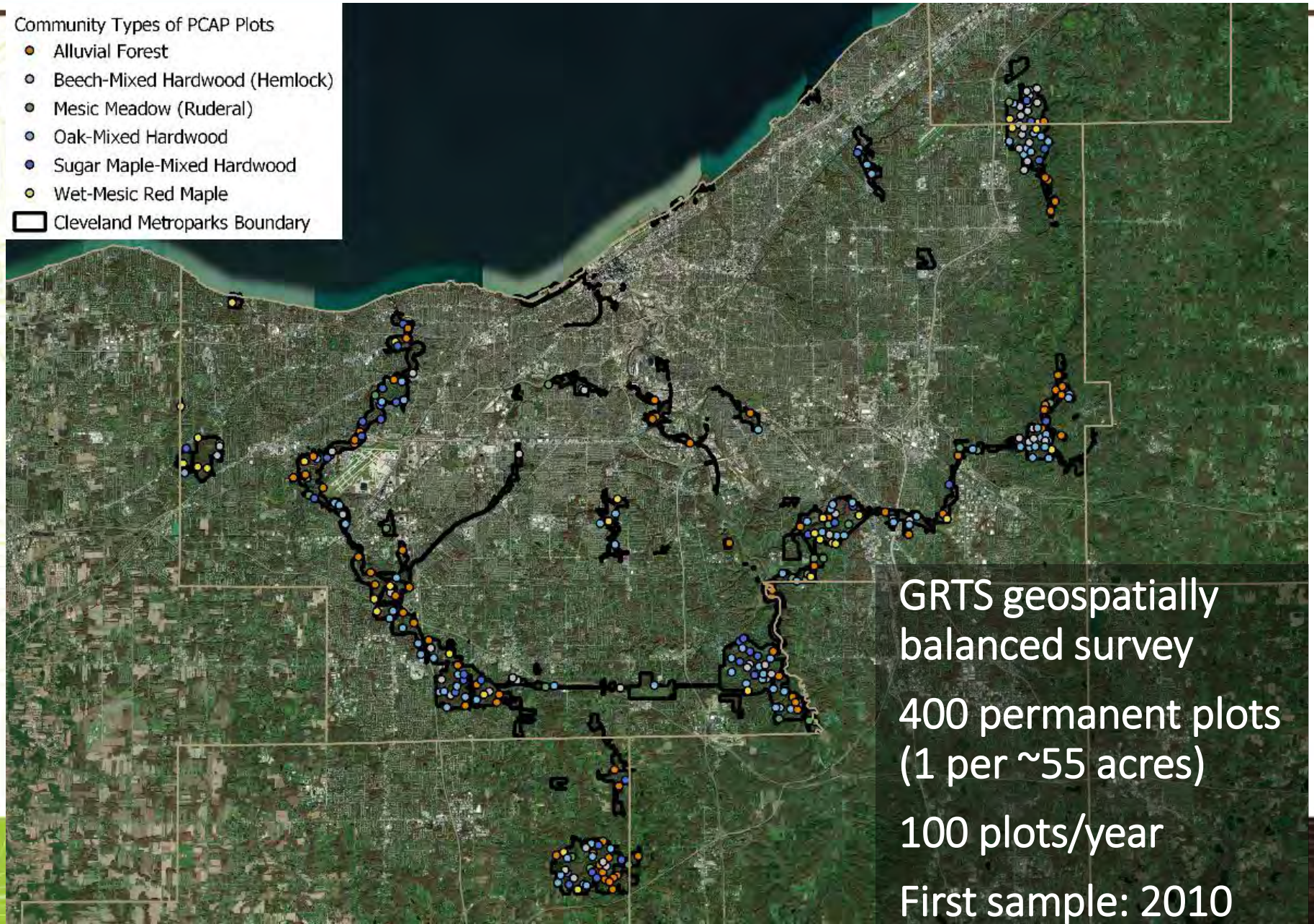
300 miles of trails

8 golf courses



2021 NRPA Gold Medal Award

Step 1: Carbon Accounting Report



GRTS geospatially balanced survey

400 permanent plots (1 per ~55 acres)

100 plots/year

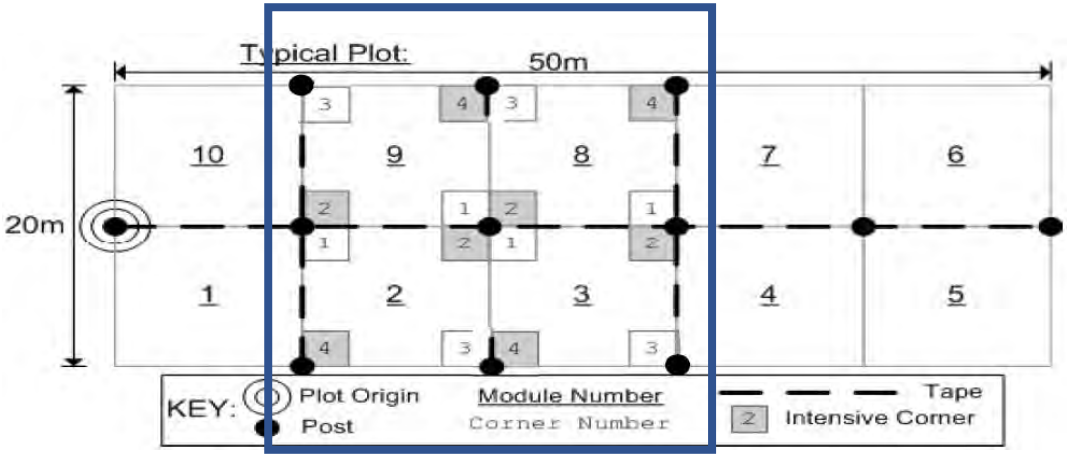
First sample: 2010

Step 1: Carbon Accounting Report

Plant Community Assessment Program (PCAP)

North Carolina Vegetation Survey (Peet et al., 1998; Lee et al., 2008)

20x50m plots (0.1 ha)



Intensive modules (2, 3, 8, 9) with more data

Step 1: Carbon Accounting Report

Preliminary & Full Reports

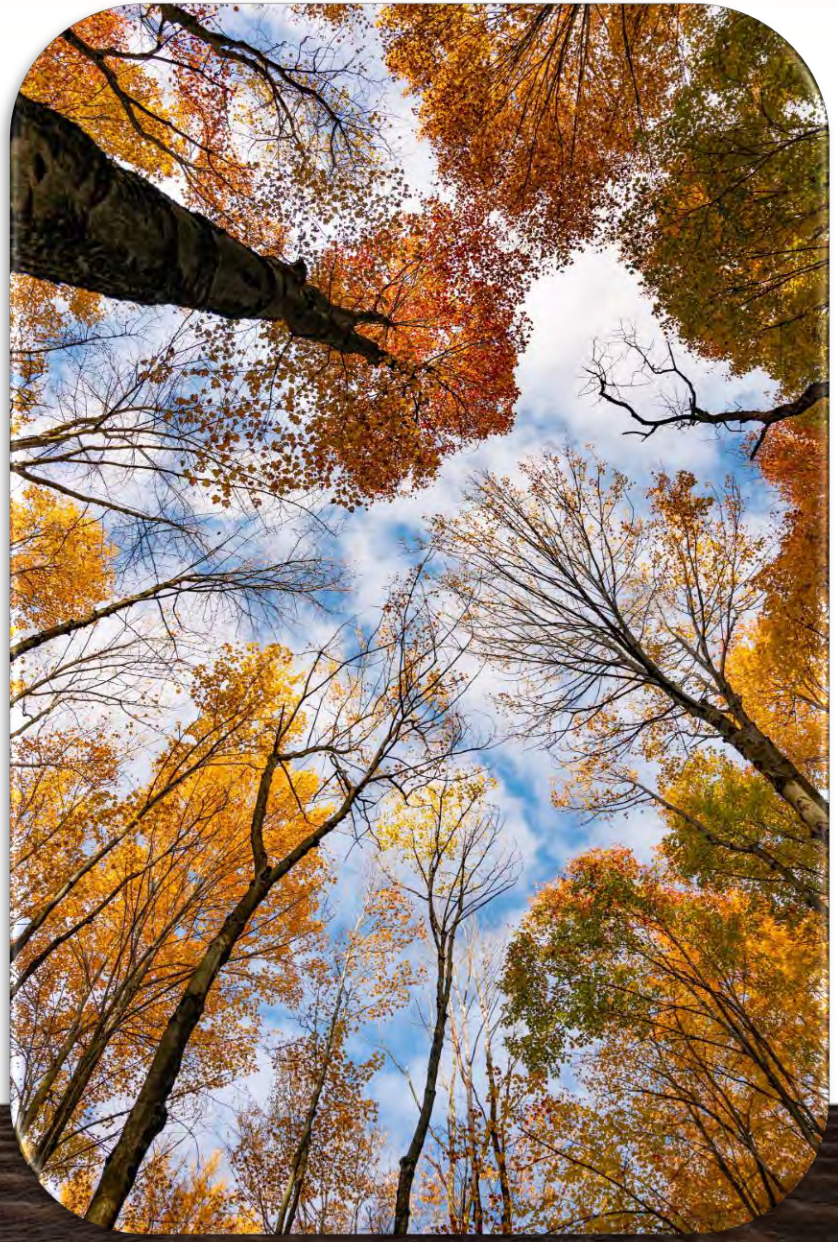
	Preliminary Report (iTree)
# plots	100 (two repeat visits)
Plot sample size	0.04 ha (40% of plot)
Years	2010, 2015, 2021
Stem size	>10 cm
Total stems	1,700
Input data	Species, dbh, crown light exposure, dieback
Future projections	No

Tools for Assessing and Managing
Forests & Community Trees

Preliminary Carbon Accounting Report

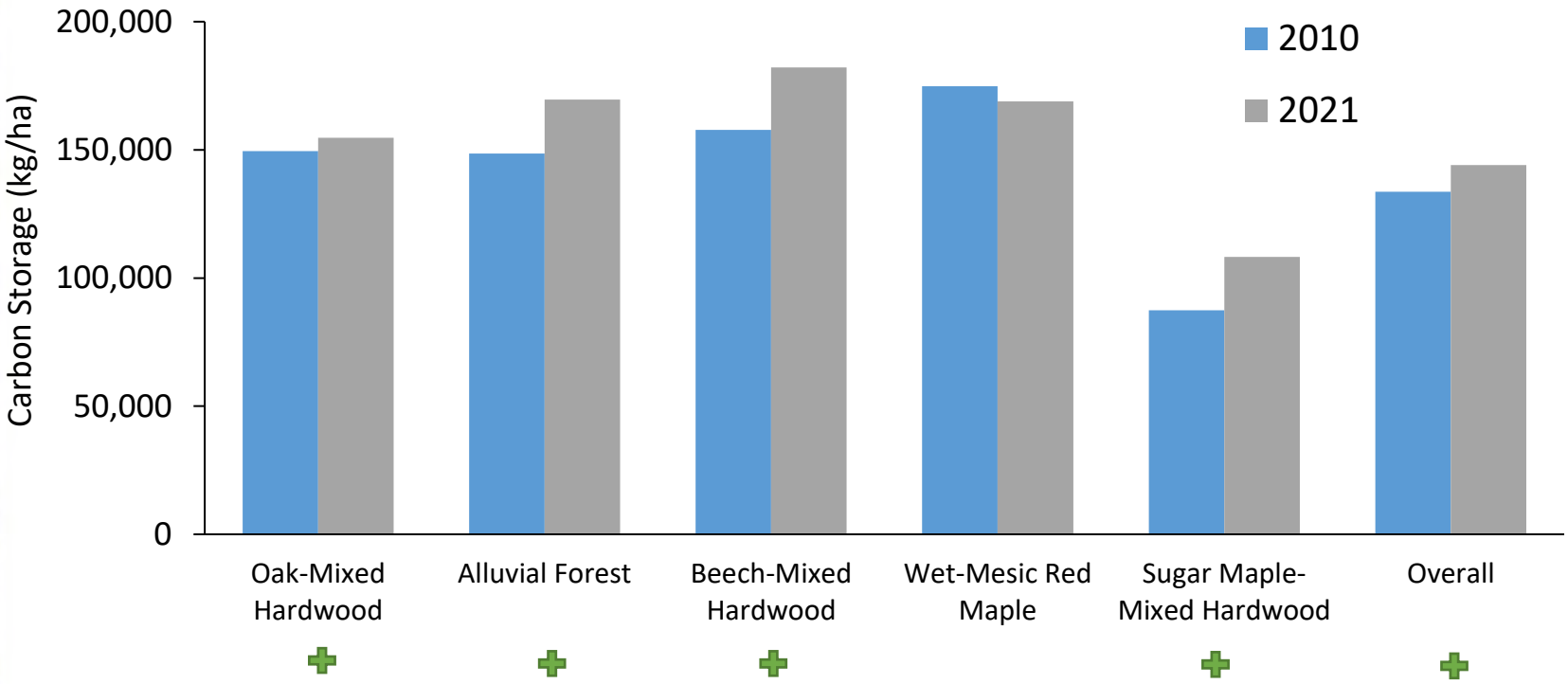
Highlights

- <u>Increase in:</u>
  - Canopy coverage (80% -> 87%)
  - Tree size
  - Total carbon storage
    (911,200 mt C -> 983,500 mt C)
- Carbon storage above average
  - 144.1 mt C ha^{-1}
- Sequestration above average
  - 0.299 $\frac{\mathbf{kg\ C}}{\mathbf{m^2\ year}}$

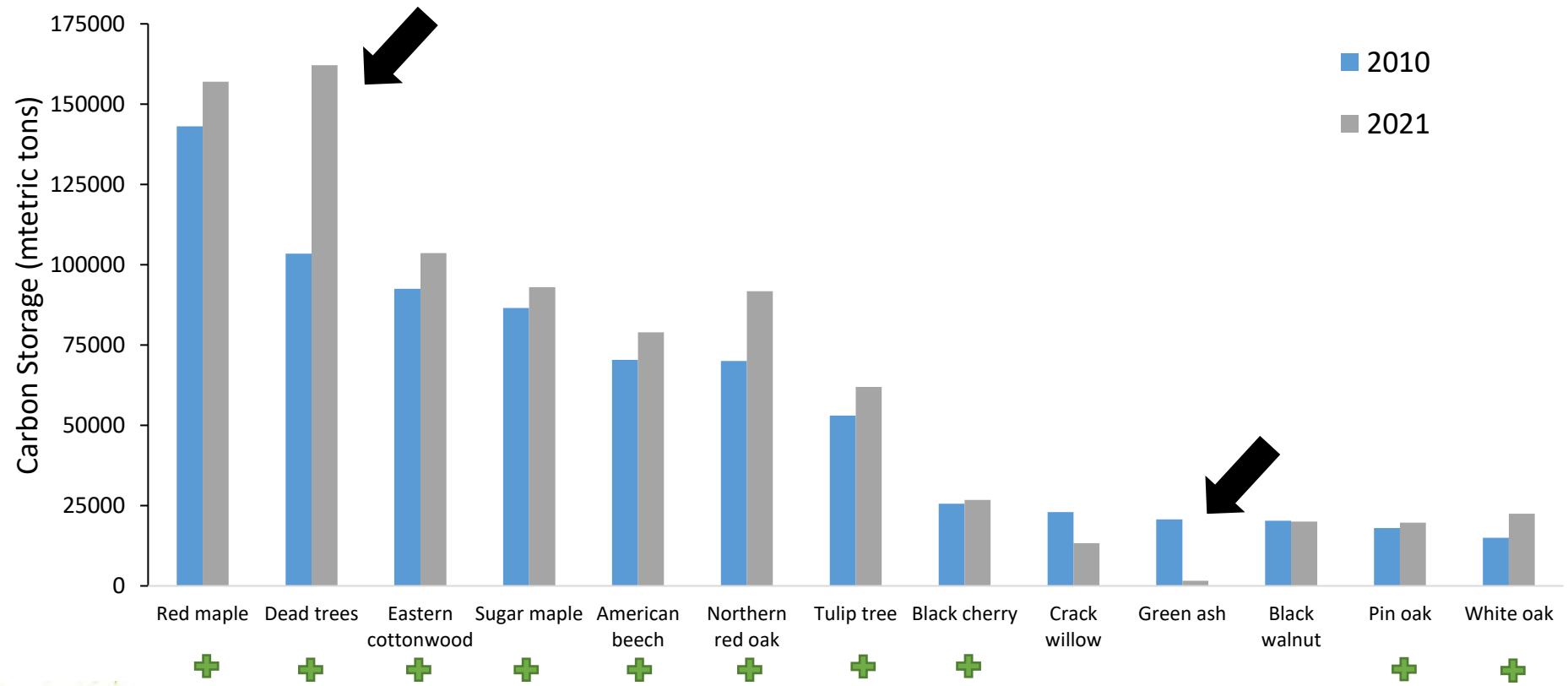


Cleveland Metroparks
FINDYOURPATH

Carbon storage



Carbon storage



Carbon storage

Top 10 largest species

Only 3/10 are Good or better

Species Name	Average DBH (cm)	Average Carbon Storage (kg)	Average Carbon Sequestration (kg/yr)
Eastern cottonwood	66.0	1833.5	35.0
American sycamore	57.9	818.7	21.3
Cucumber tree	57.8	1443.2	27.3
Eastern white pine	47.0	388.4	13.0
Crack willow	46.3	584.3	17.3
Black walnut	43.9	531.2	14.4
Pin oak	41.9	563.7	17.4
Tulip tree	41.4	595.1	16.7
Chinkapin oak	40.4	499.7	20.4
Northern red oak	39.8	720.1	15.0

Carbon storage

Top 10 Largest Individuals Assessed

Species Name	DBH	Replacement Value †	Carbon Storage		Gross Carbon Sequestration		Total Annual Benefits
	cm	$	Kg	$	Kg/yr	$/yr	$/yr
Eastern cottonwood	122	2447.08	7500*	1410.00	8.10	1.53	15.99
Northern red oak	112	8111.62	5001	940.23	51.40	9.67	25.52
Black walnut	106	5085.03	2511	472.07	41.20	7.75	26.69
Eastern cottonwood	99	4059.91	4516	848.98	58.80	11.05	21.94
Northern red oak	98	6671.19	3583	673.67	62.30	11.71	23.73
Northern red oak	95	6562.05	3331	626.21	65.50	12.32	24.35
Bitternut hickory	94	4417.99	2816	529.40	21.60	4.07	32.40
Eastern cottonwood	94	3727.72	3912	735.43	60.50	11.37	22.36
Eastern cottonwood	93	3544.17	3787	712.01	58.90	11.07	21.60
Black walnut	92	4149.06	1825	343.05	48.40	9.09	22.70

*represents maximum value estimated by iTree
†Replacement value based on trunk area (cross-sectional area at dbh), species, condition, and location

Carbon storage & sequestration

How does Cleveland Metroparks compare?

	Average Carbon Storage
Average from Nowak et al. 2013	76.9 mt C/ha
Average Ohio from Nowak et al. 2013	70.9 mt C/ha
Cleveland Metroparks	144.1 mt C/ha

Carbon sequestration

2021: = 20,410 mt C/yr

= 74,837 mt CO2e/yr

$$= 0.299 \frac{\text{kg C}}{\text{m}^2 \text{ year}}$$

Carbon sequestration

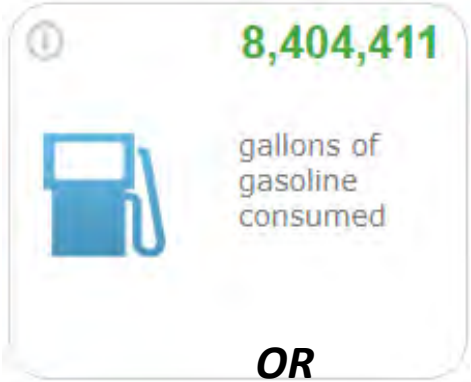
2021: = 20,410 mt C/yr

= 74,837 mt CO2e/yr

$$= 0.299 \frac{\text{kg C}}{\text{m}^2 \text{ year}}$$

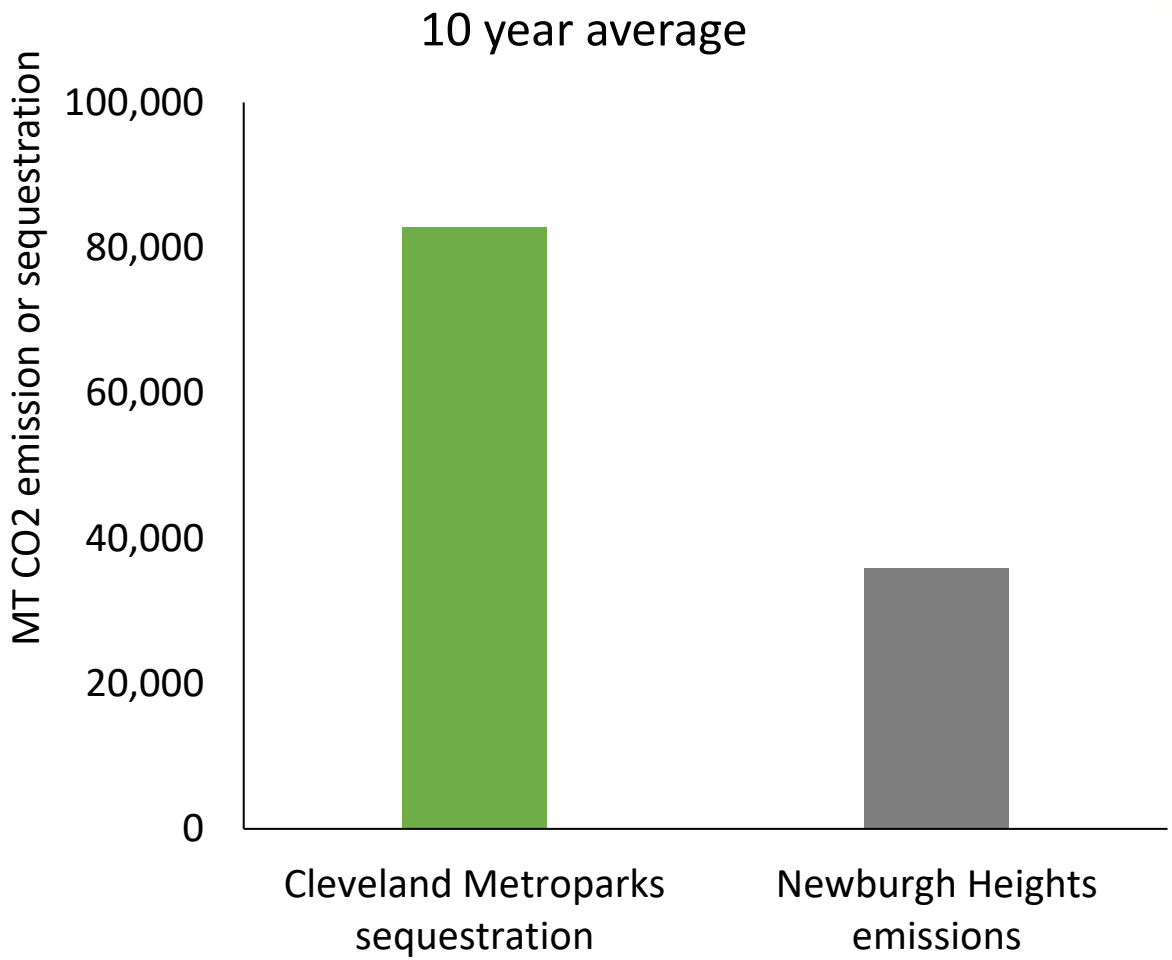
What does that mean?

[US EPA Carbon Calculator]



Carbon sequestration & local emissions

Newburgh Heights population = ~2,000

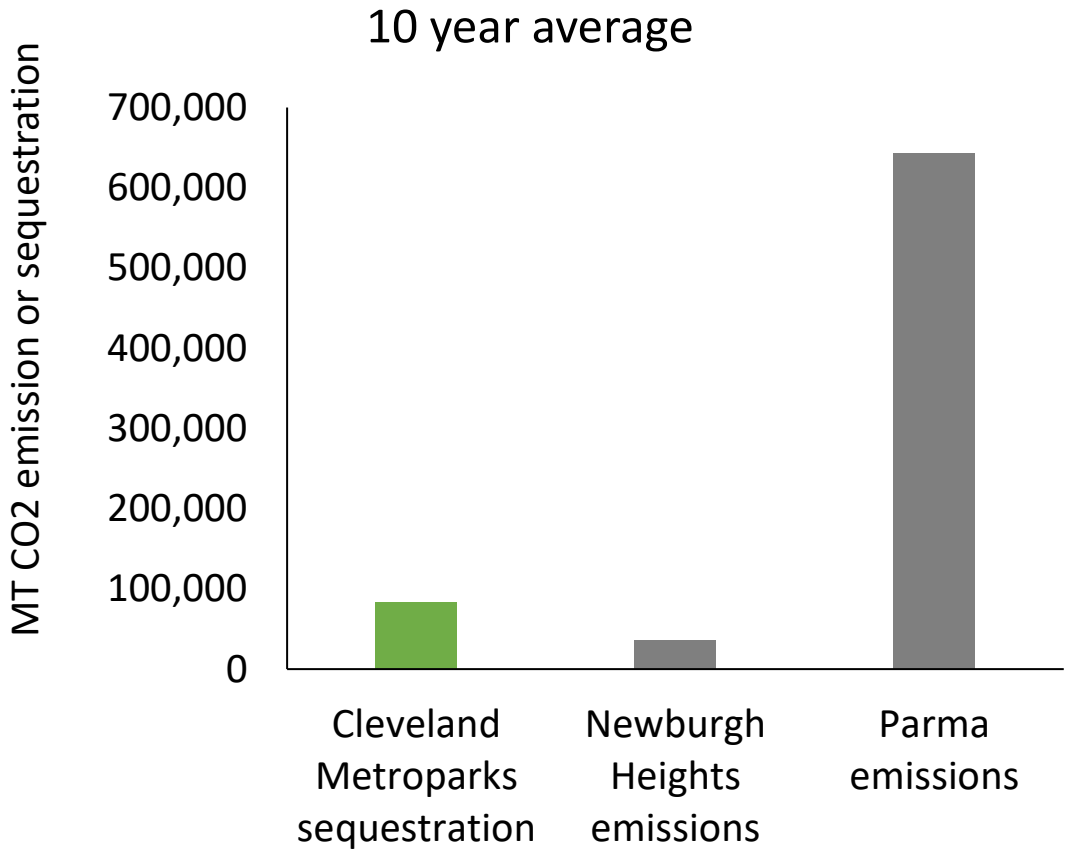


Data from [Cuyahoga County Planning Commission, Climate Action Plan]

Carbon sequestration & local emissions

Newburgh Heights population = ~2,000

Parma population = ~79,000



Data from [Cuyahoga County Planning Commission, Climate Action Plan]

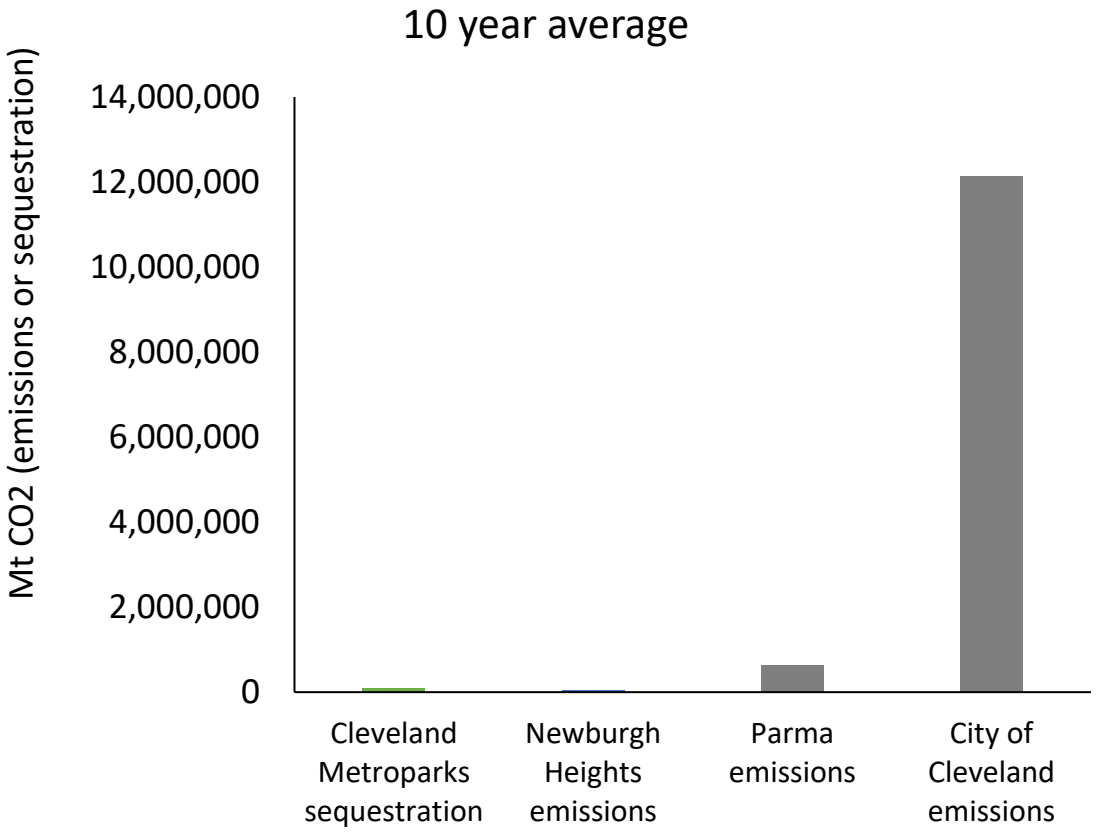
Carbon sequestration & local emissions

Newburgh Heights population = ~2,000

Parma population = ~79,000

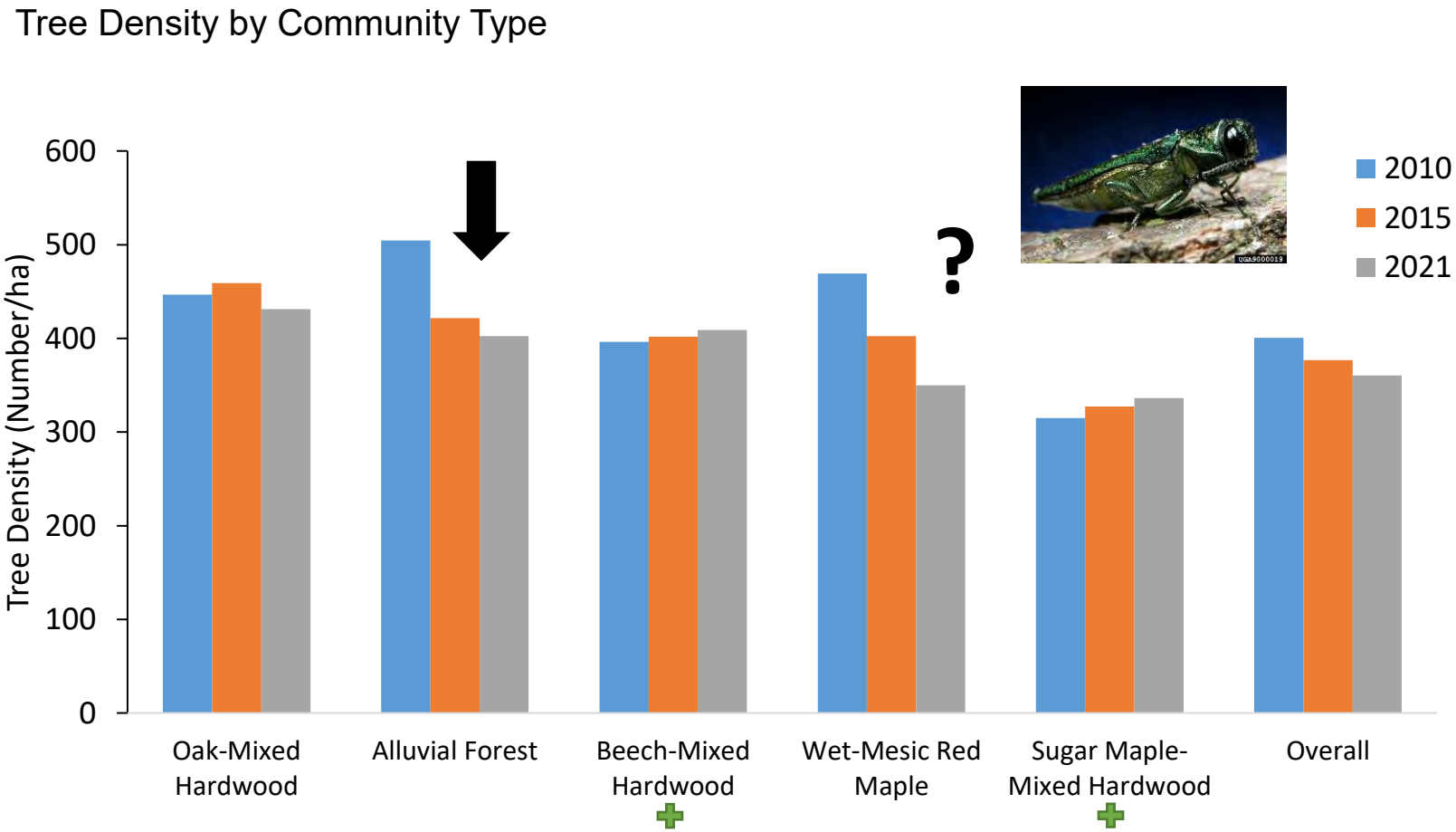
Cleveland population = ~385,000

We need more help!
Trees can't do it all. We need a collective effort to cut back emissions

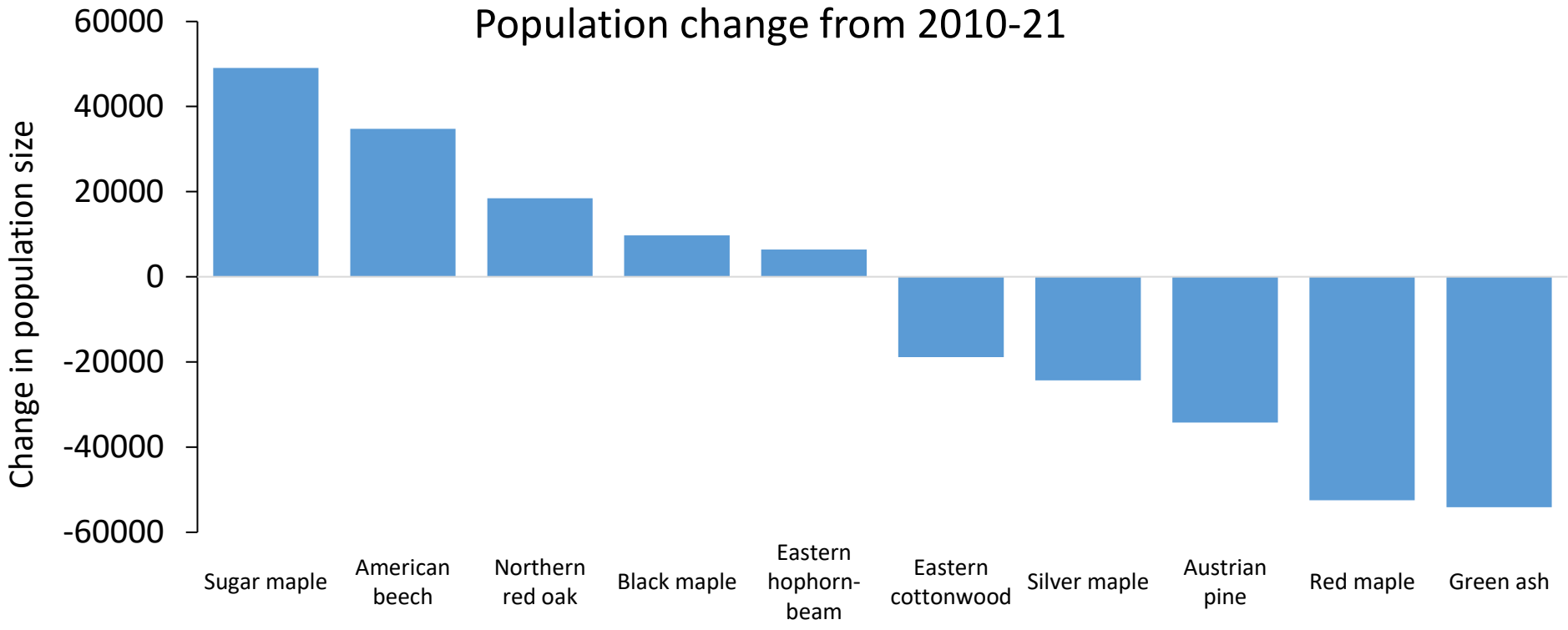


Data from [Cuyahoga County Planning Commission, Climate Action Plan]

Forest composition

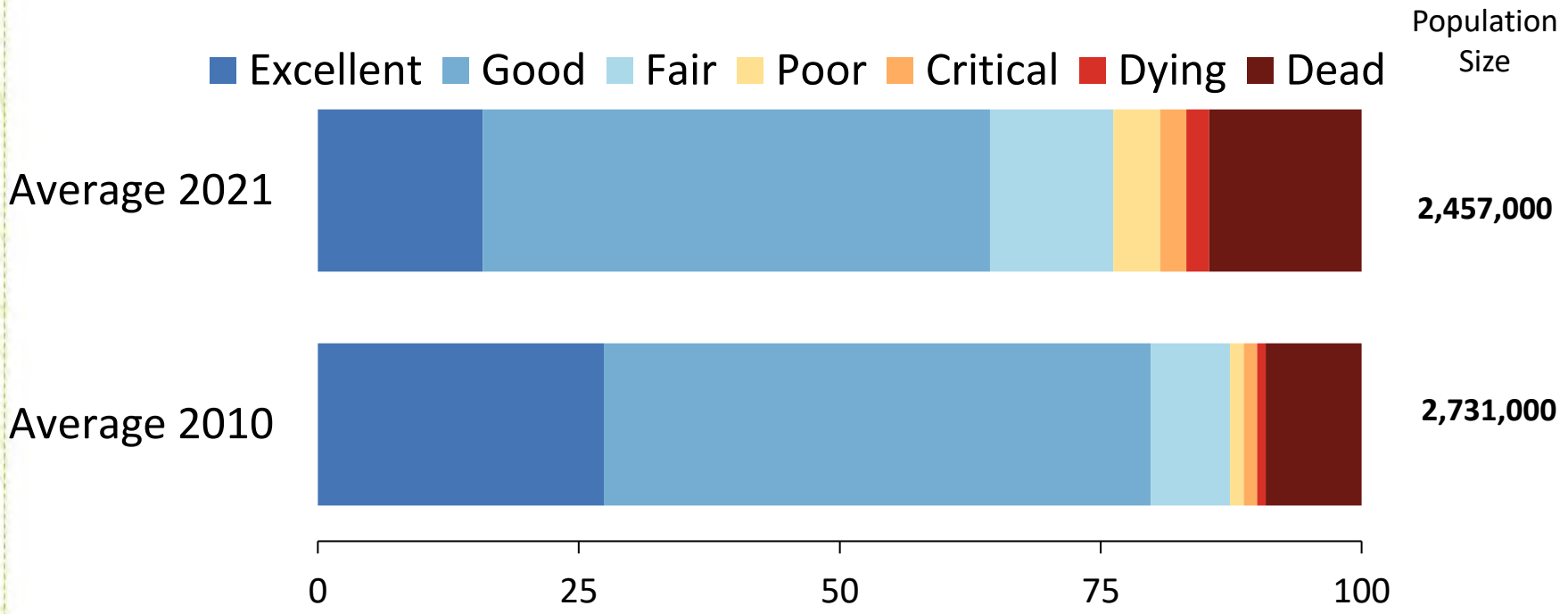


Forest composition

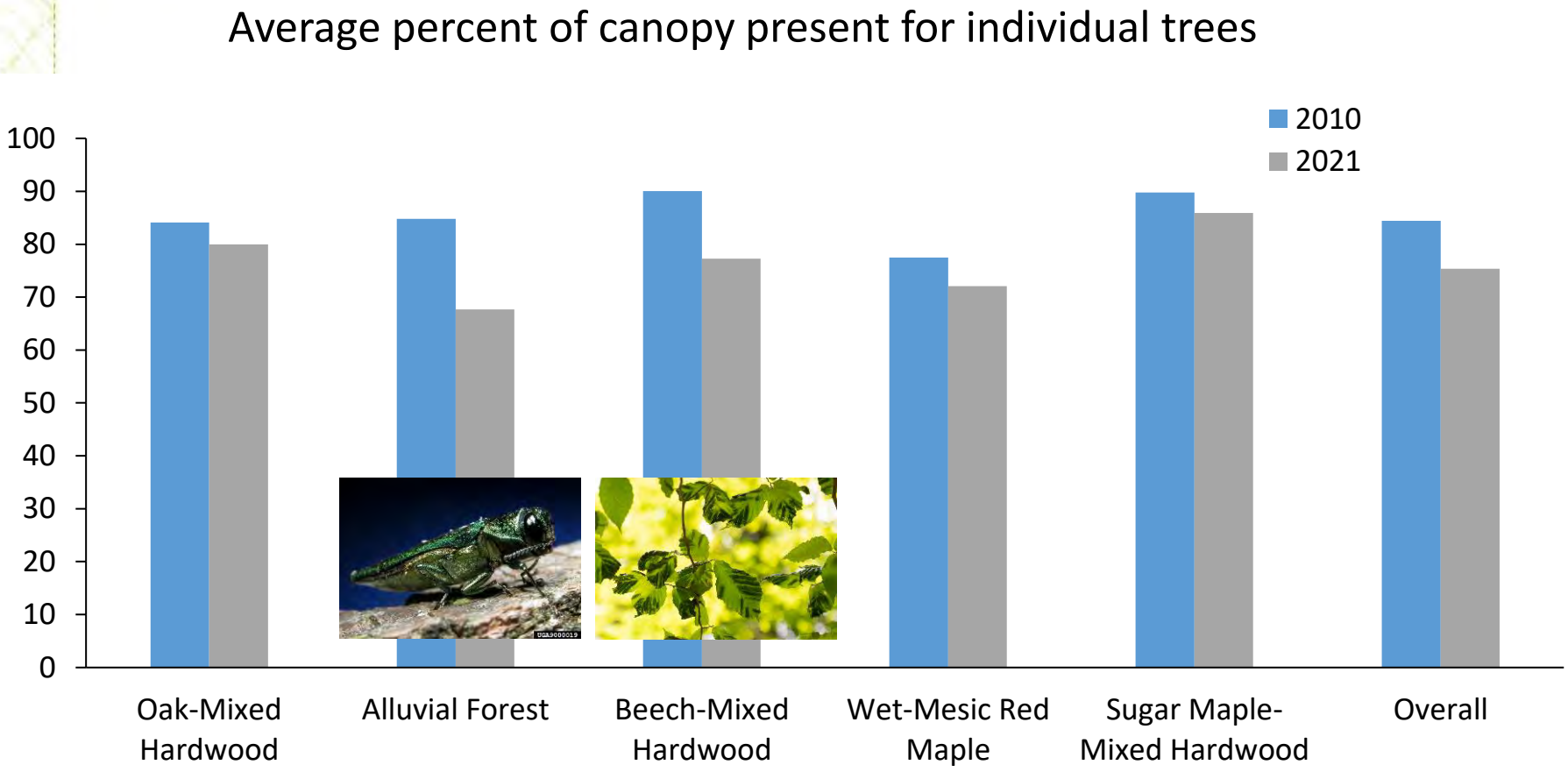


Forest health

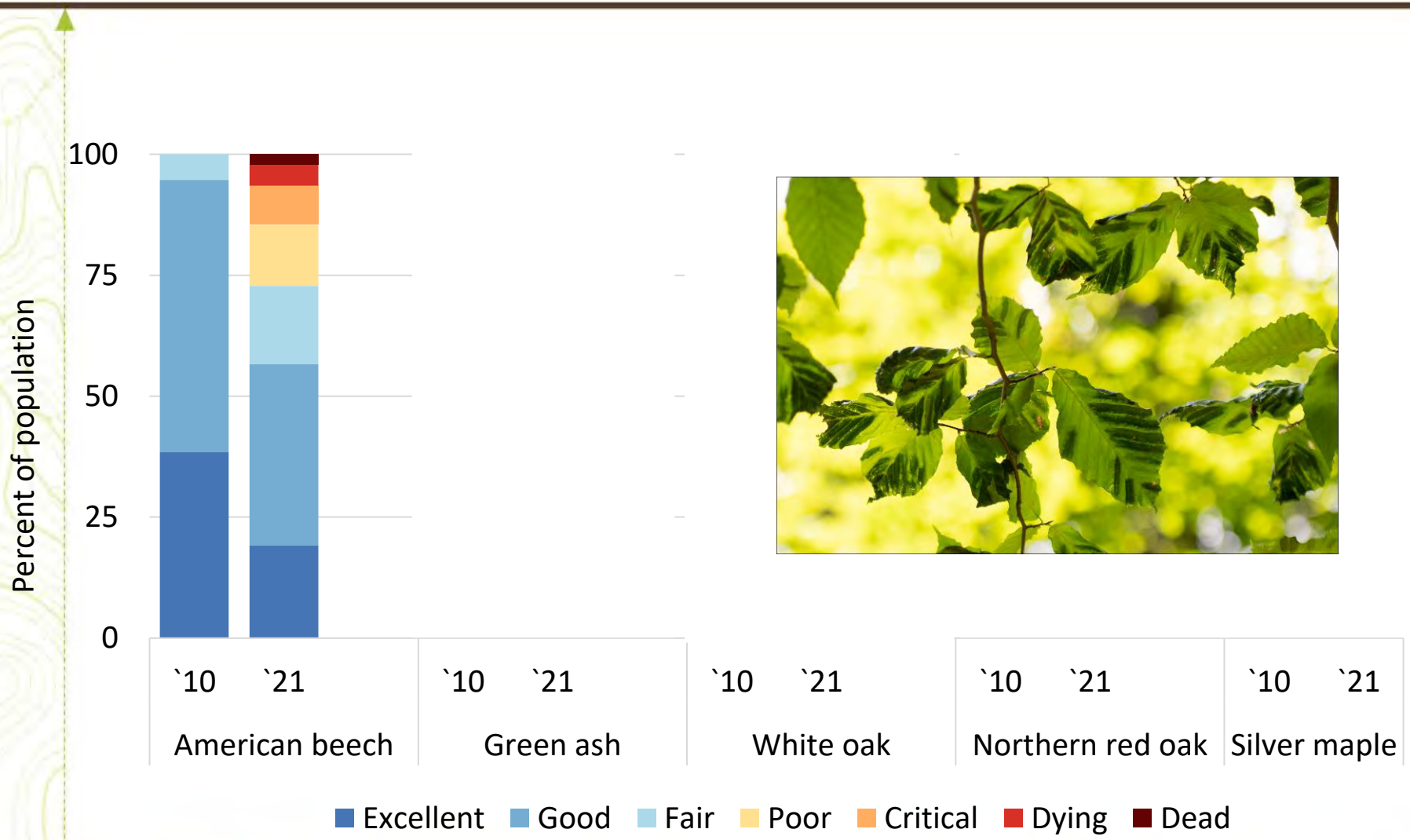
2010 to 2021 Species Health Rating Changes



Forest health



Forest health



Full Carbon Accounting Report – Future Projections

Model implementation to project future forest conditions

FVS is a growth and yield model based on individual tree data

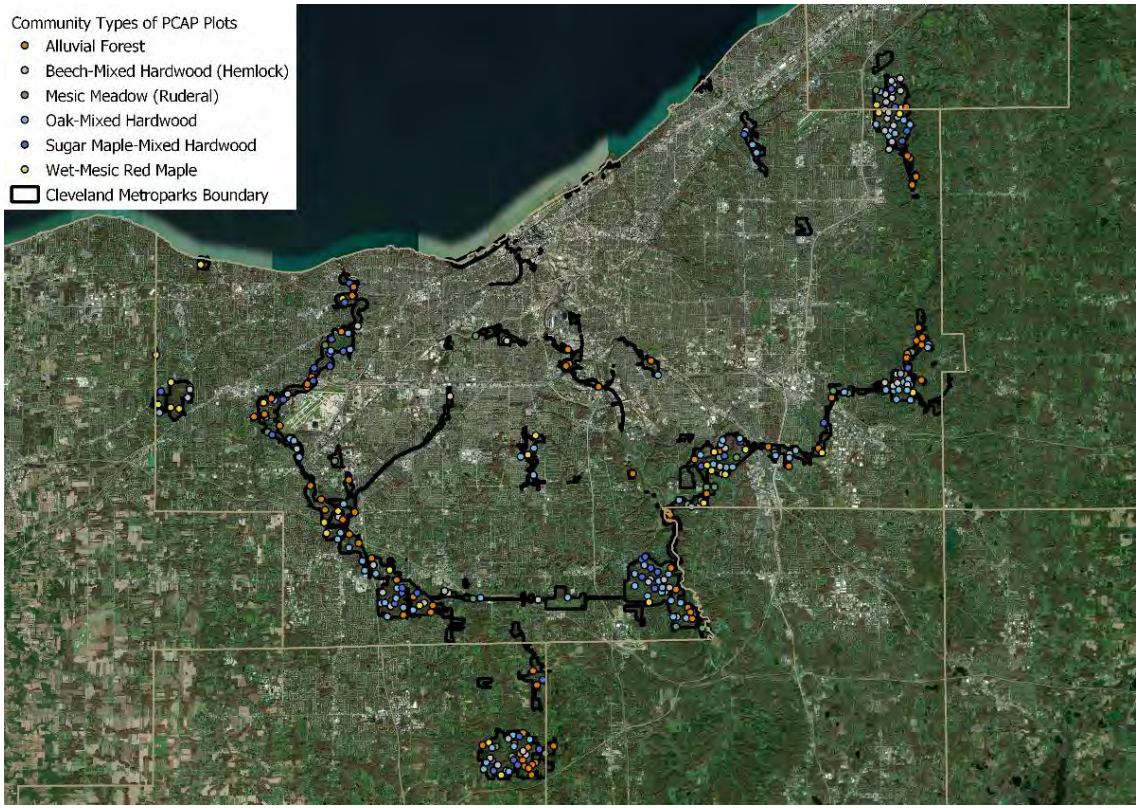
Full Carbon Accounting Report – Future Projections

Preliminary report

- 2010-2021
- iTree
- 100 plots
- ~1,700 trees

Full report

- Future projections
- Forest Vegetation Simulator (FVS)
- 400 plots
- ~50,000 stems



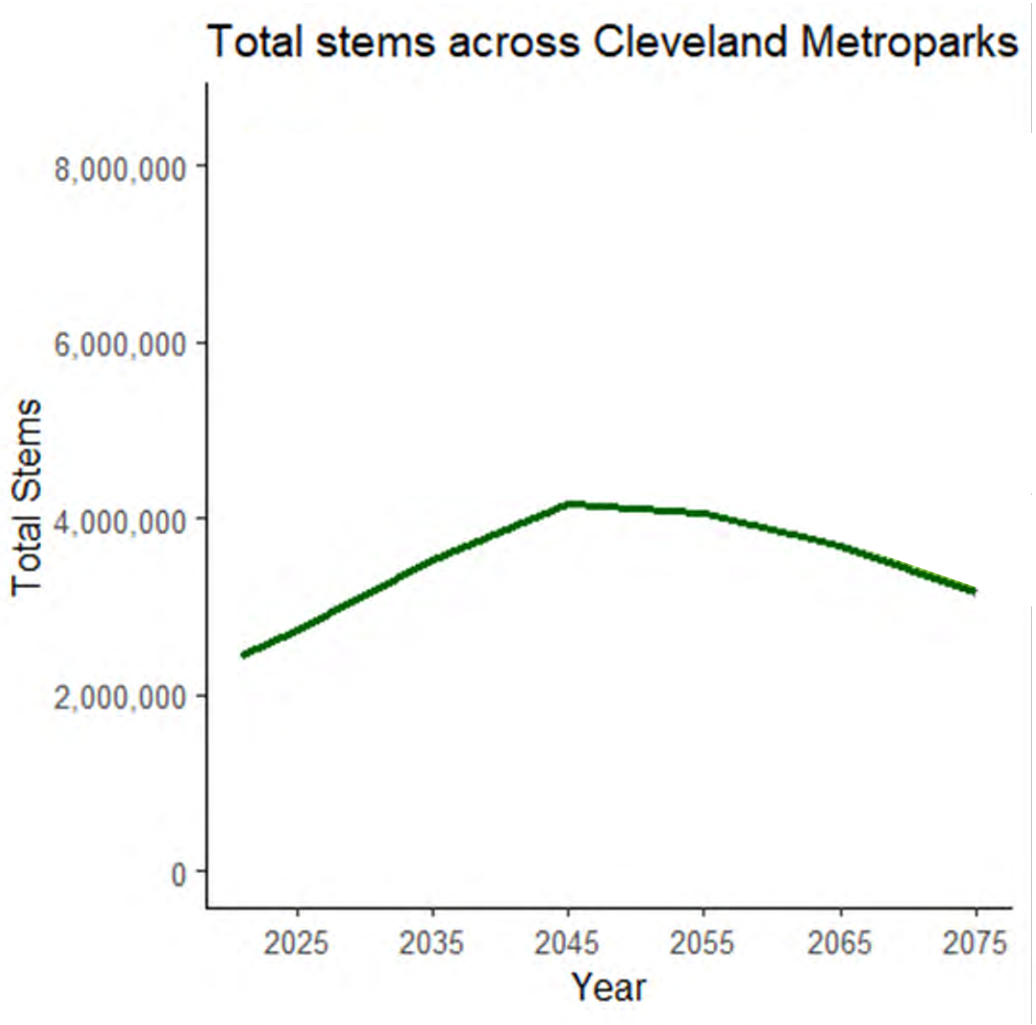
i-Tree
Tools for Assessing and Managing
Forests & Community Trees

Forest Vegetation Simulator
FVS

Full Carbon Accounting Report – Population Size

Initial increase in tree population, decline after 2045

- There is potential to increase tree population



Trees = > 4 inches

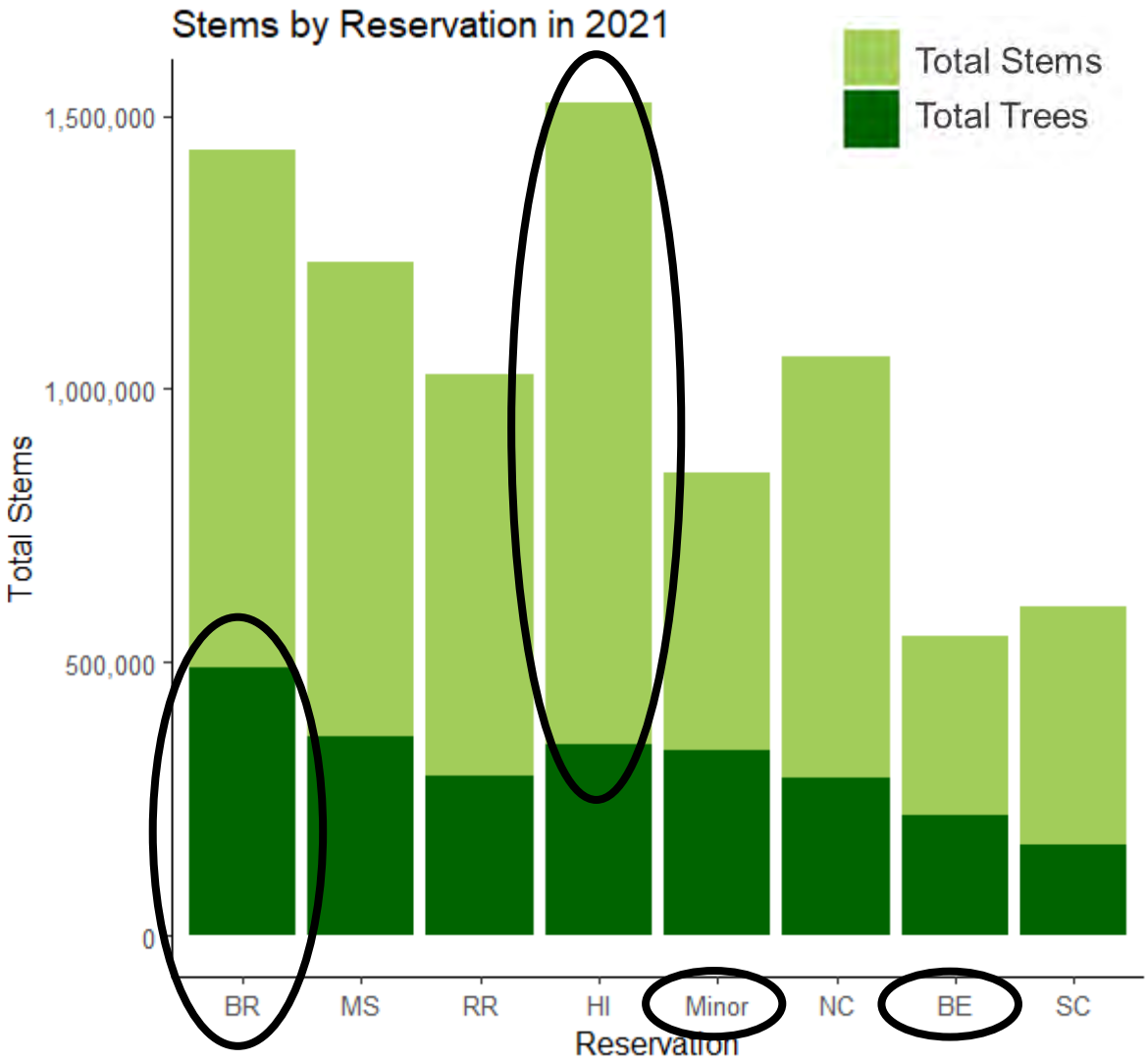
Full Carbon Accounting Report – Populations

Hinckley & Brecksville Reservations have highest stem count

Brecksville has highest *tree* count

Bedford & Minor have highest proportion of trees

Hinckley has lowest proportion of trees

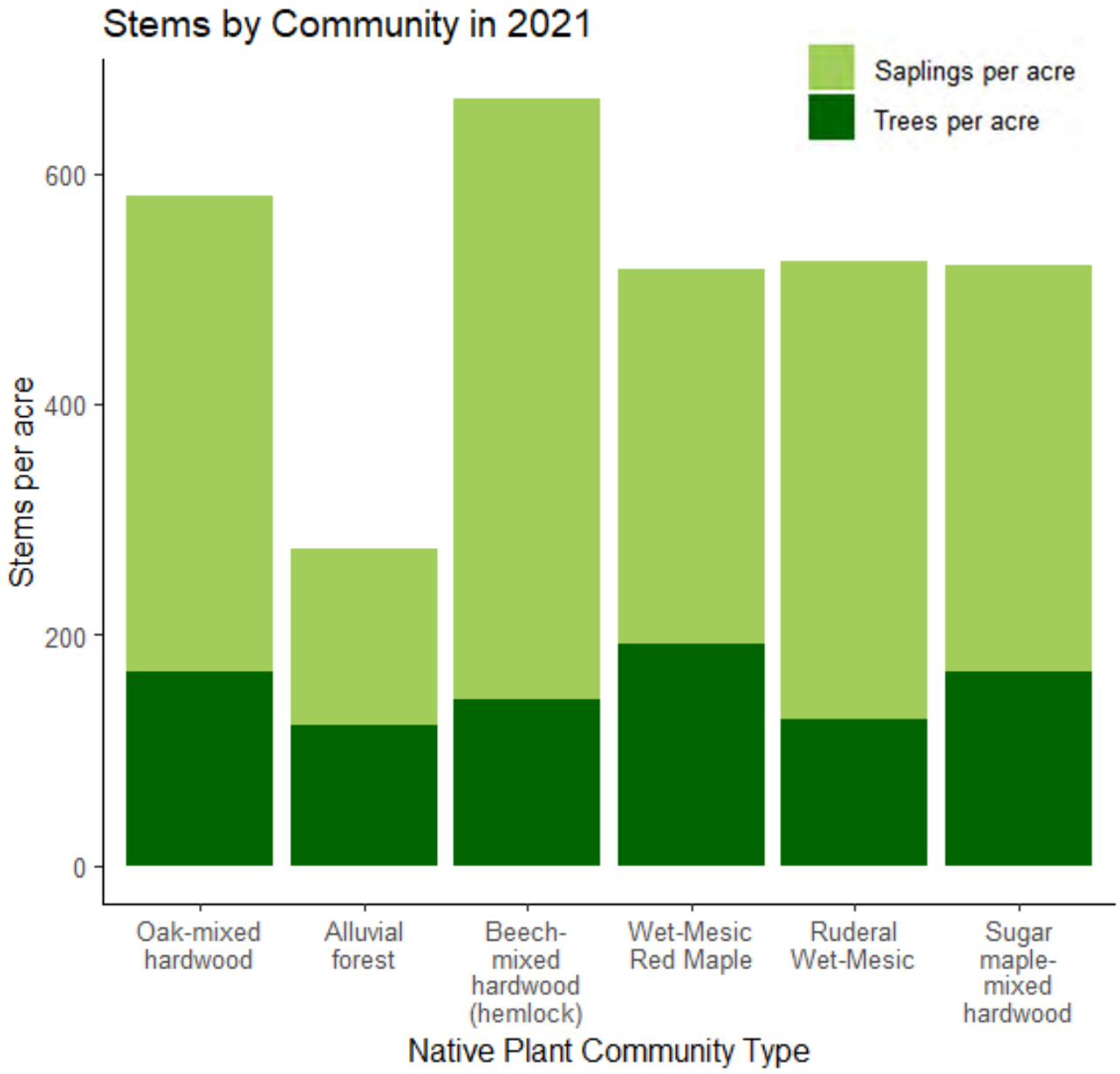


Stems = >0.1-inch diameter
Trees = > 4 inches diameter

Full Carbon Accounting Report – Plant Communities

Beech-mixed hardwood and oak-mixed hardwood have highest stem density

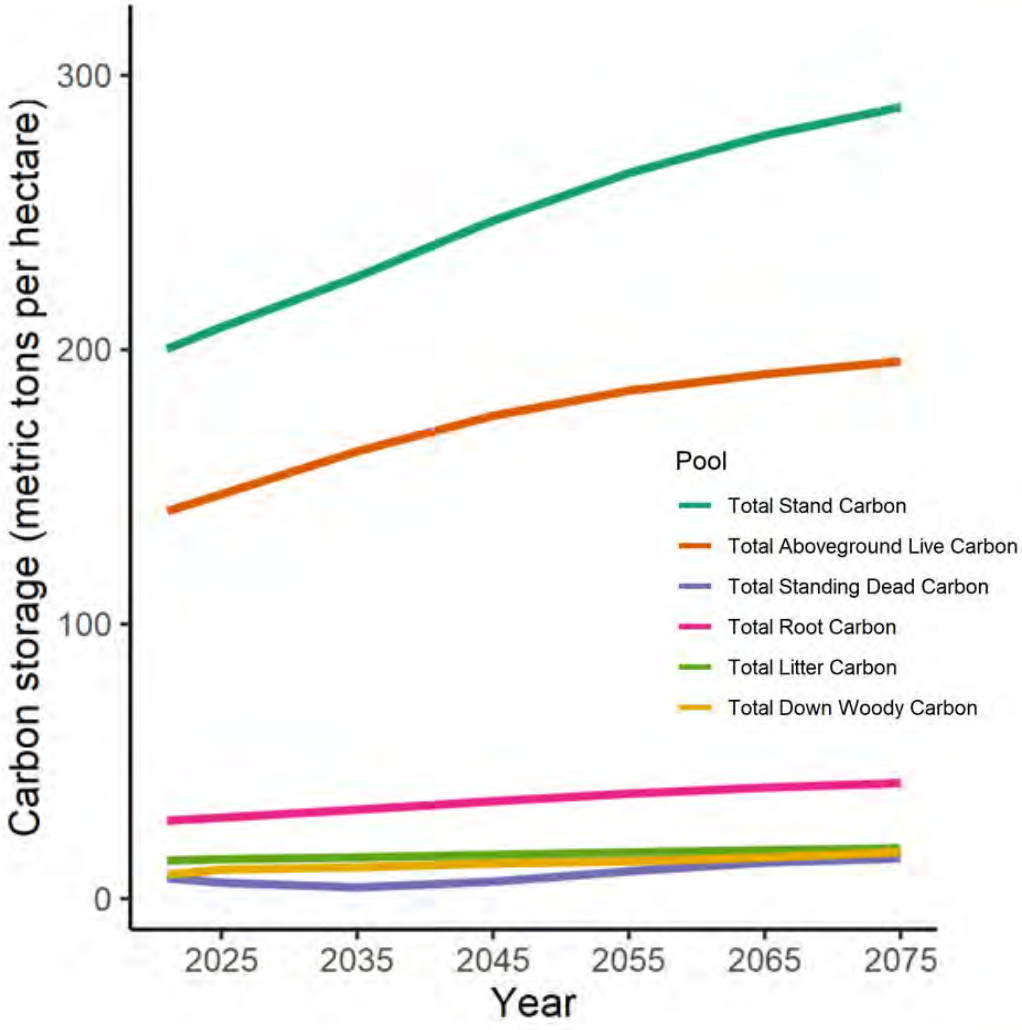
Alluvial forest has highest proportion of trees



Cleveland Metroparks FINDYOURPATH

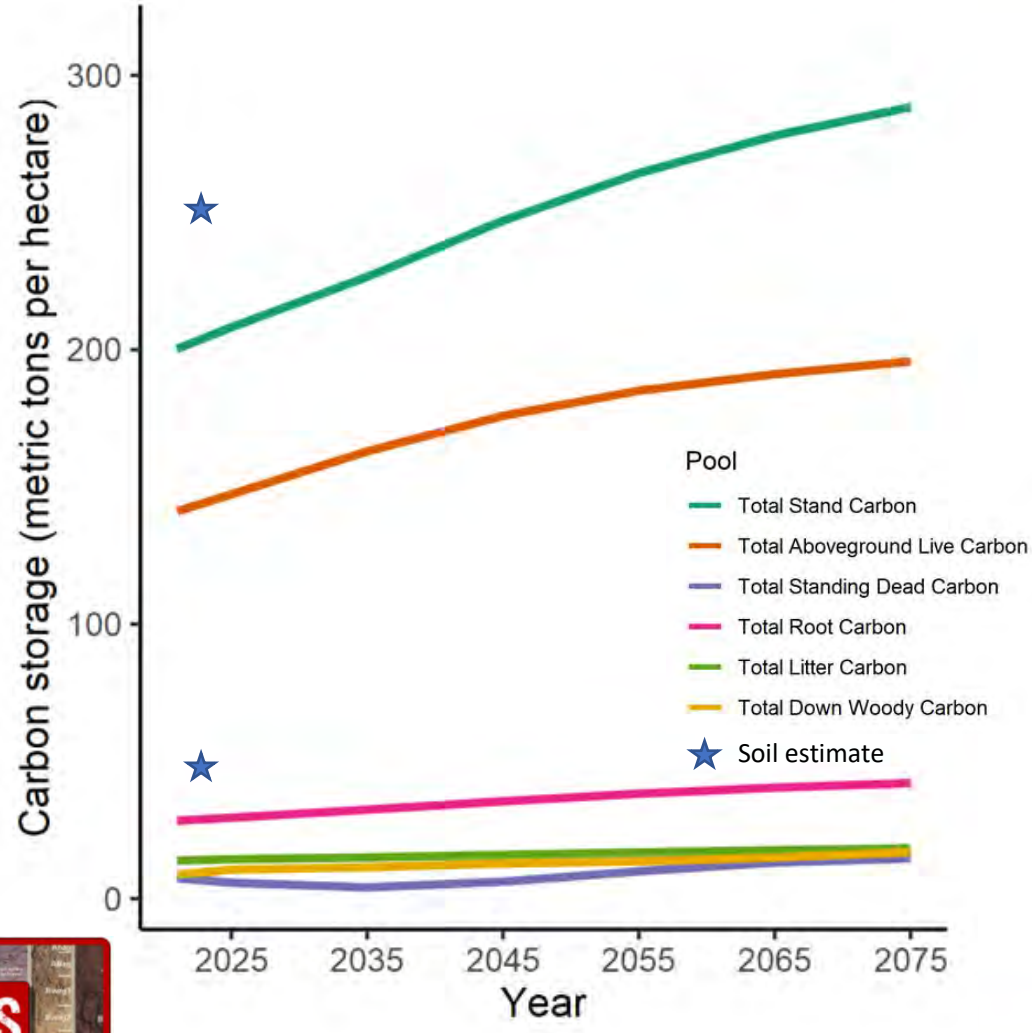
Full Carbon Accounting Report – Carbon

- All carbon pools increase over time
- Total carbon storage = 200 mt/ha
- Most carbon stored in aboveground live (trees) = 141 mt/ha
- No soil estimated with FVS, but…

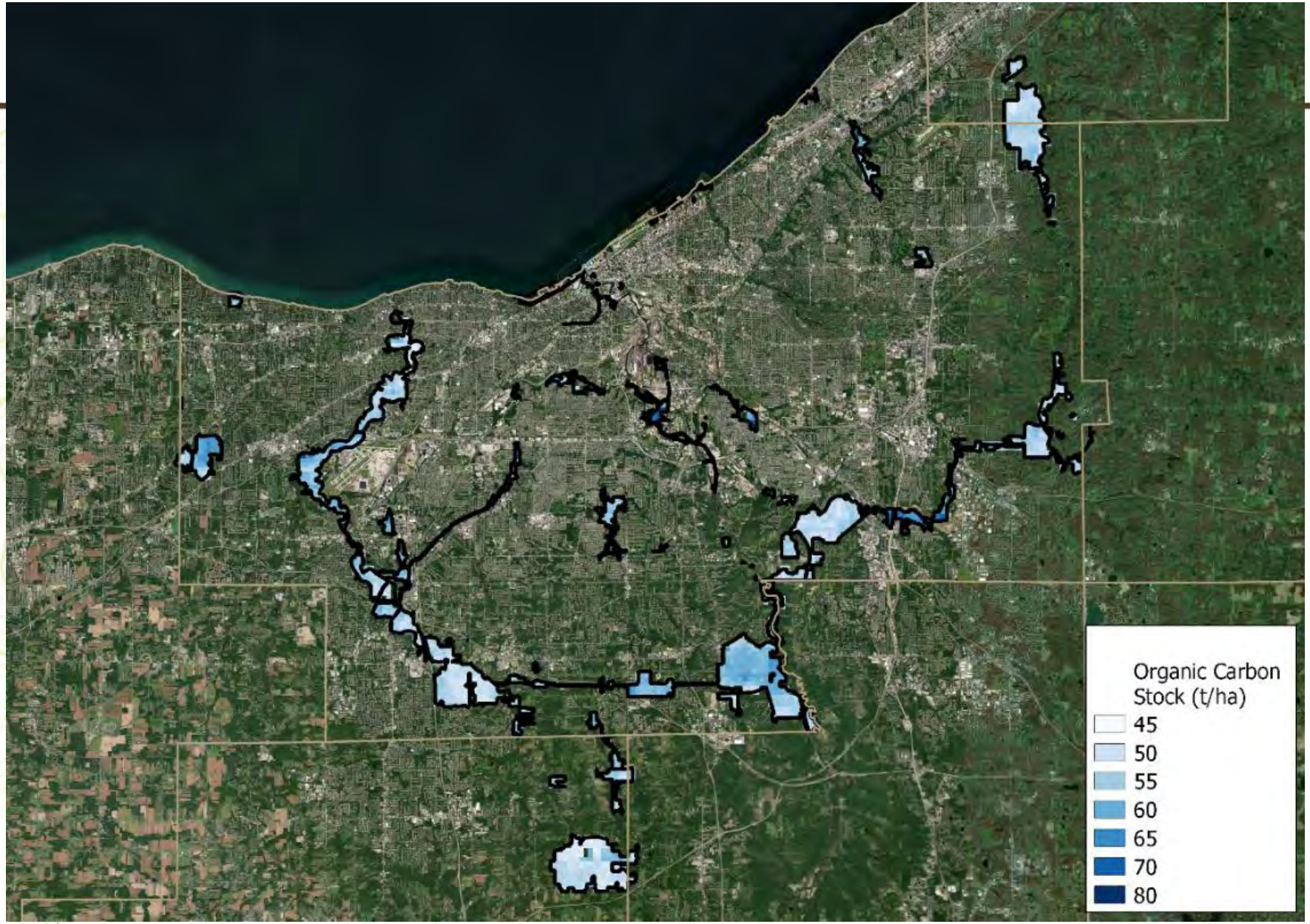


Full Carbon Accounting Report – Carbon

- All carbon pools increase over time
- Total carbon storage = 255 mt/ha
- Most carbon stored in aboveground live (trees) = 141 mt/ha
- No soil estimated with FVS, but…
- SoilGrids estimate = 55 mt/ha



SoilGrids models soil properties and maps them across the globe based on machine learning from over 400 environmental covariates (Poggio et al., 2021).


Organic Carbon Stock (t/ha)
45
50
55
60
65
70
80

Carbon Estimate Comparison

	Year(s)	Source	Geographic Extent	Carbon Pools	Gross Annual mt CO2 Sequestration per Acre	Total mt CO2 per Acre
FVS (Full Report)	2015-18	400 plots	Cleveland Metroparks Natural Areas	Aboveground live & dead, belowground, leaf litter, down wood, herbaceous	3.4	363.6
i-Tree Eco (Prelimin-ary)	2021	100 plots[1]	Cleveland Metroparks Natural Areas	Aboveground live & dead (no saplings)	3.9	213.8
TNC Resilient Land	2010	USFS FIA plots[2]	All Cleveland Metroparks	Aboveground live & dead, down wood, and soil/other	0.7	291.9
ICLEI LEARN Tool	2013-19	Landsat satellite imagery[3]	All Cleveland Metroparks	-	2.0	-

Step 2: Forest Management

Management strategies to maximize carbon storage and ecosystem resilience

Simulate timber stand improvement (TSI) activities like:

- Forest thinning
- Underplanting trees
- Invasive plant management
- Deer management

Benefits:

- Increase vigor of remaining trees
- Increase tree and understory diversity
- Decrease disease spread

Step 2: Forest Management

Examples of forest management:

Fencing allows:

- Exclusion of deer
- Regeneration of seedlings
- Protection of restoration

August 2014

2018

Step 2: Forest Management

Examples of forest management:

Cleveland Metroparks currently has 29 fences protecting ~44 ac

One year of deer protection

Step 2: Forest Management

Examples of forest management:
Thinning poorly formed, dense red maple forest

Ensure:
- Resilient Forest
  - Tree regeneration

Enhance:
- Species tolerant to climate change
- Species with greater wildlife value
- Age, species and structural diversity

Reduce:
- Poorly –formed trees
- Red Maple (>73%)

Before & After

Tree Species Removed

76% red maple
14% black cherry
5% ash

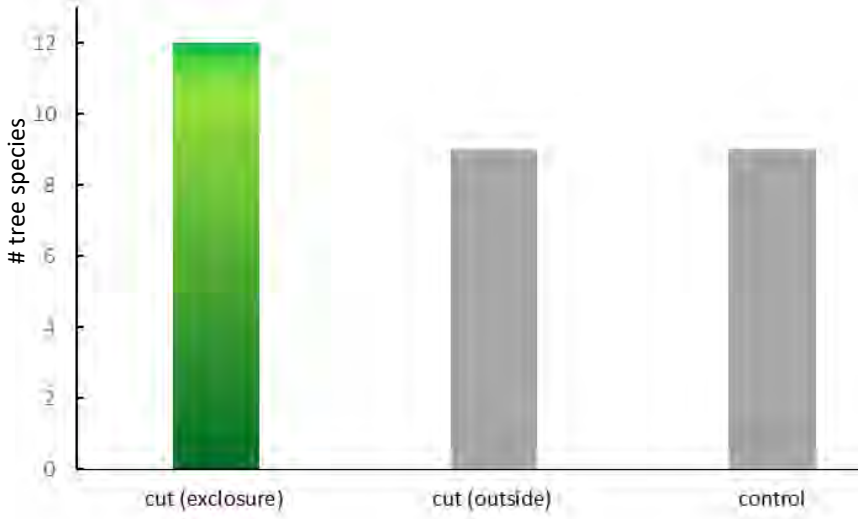
~1% sugar maple, red oak, tulip, Am. elm, beech

Step 2: Forest Management

Before **&** **After**

Step 2: Forest Management

Regeneration Survey 2021



Cut Management sites

25% more species
25% more tree species
30% taller vegetation

Step 2: Forest Management

6 Tree Species!

- American Elm
- Tulip Poplar
- Wild Black Cherry
- Green Ash
- Red Maple
- Pyrus (pear) sp.

Ensure:

- Resilient Forest
    - Tree regeneration

Enhance:

- Species tolerant to climate change
- Species with greater wildlife value
- Age, species and structural diversity

1 meter patch of forest floor

Step 3: Create Educational Resources

What are the needs of tree planters and resource practitioners?

Surveyed potential user groups to see top priorities

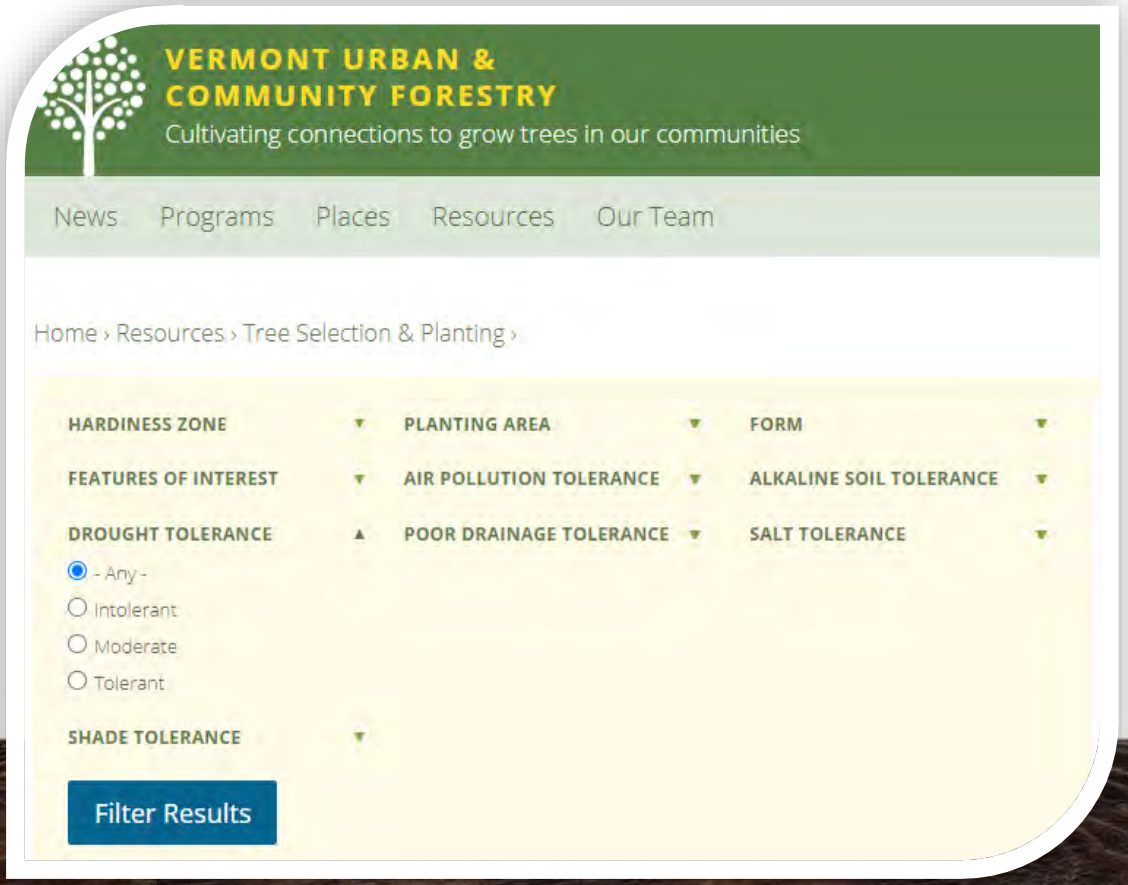
ASLA
OHIO

American Planning Association
Ohio Chapter
Creating Great Communities for All

Step 3: Create Educational Resources

Outcomes:

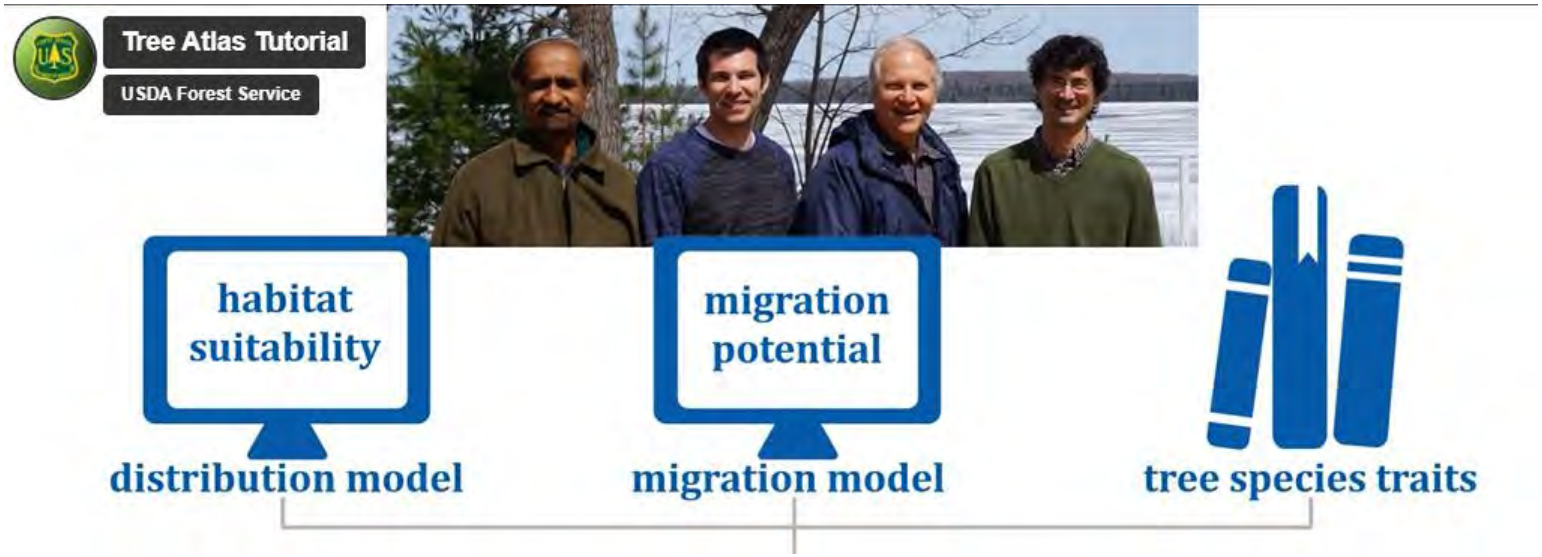
1. Need for tree selection tool
    a. Filter trees based on criteria (tolerance to drought, soil, climate tolerance)



Step 3: Create Educational Resources

Outcomes:

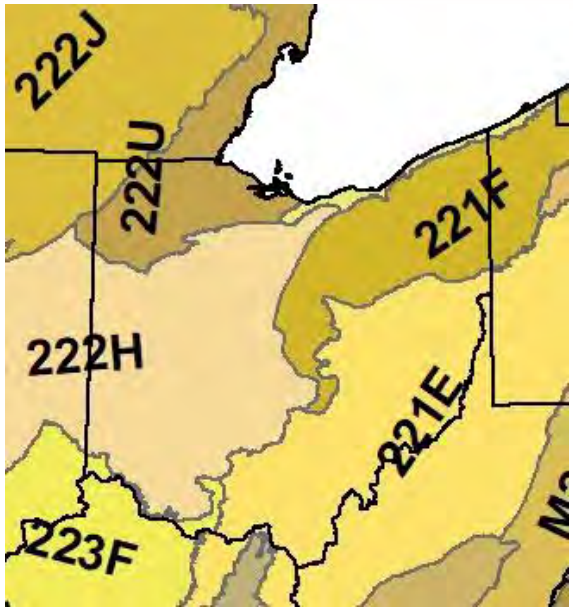
1. Need for tree selection tool
    a. Filter trees based on criteria (tolerance to drought, soil, climate tolerance)
        a. USFS Climate Change Tree Atlas

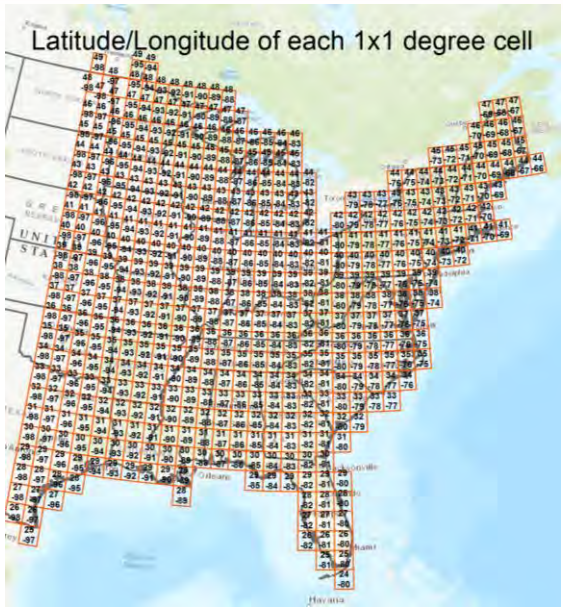


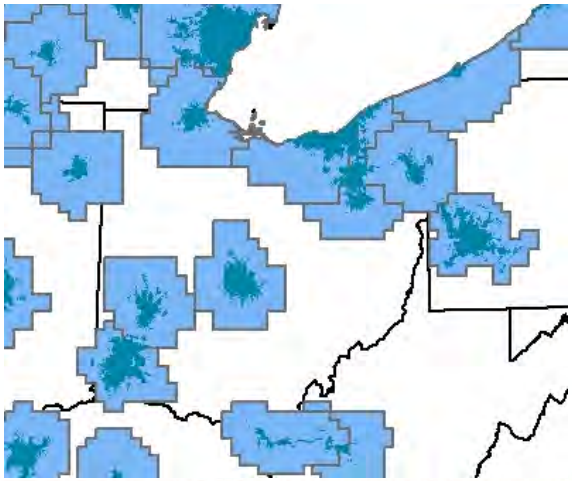
Step 3: Create Educational Resources

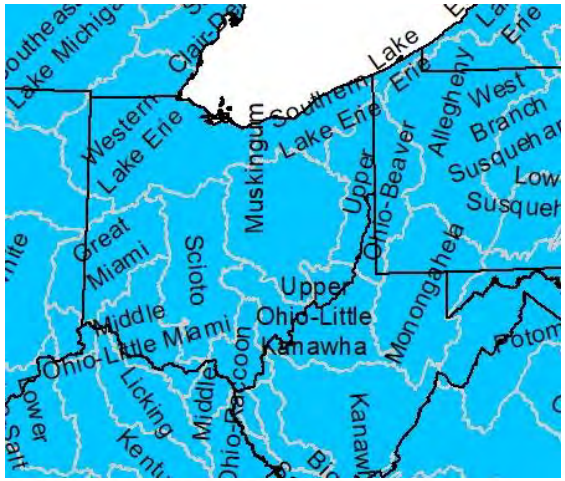
USFS Climate Change Tree Atlas summary by:

- Region (Midwest, Northeast, etc.)
- Ecoregion
- HUC6 watershed
- Urban center
- 1x1 degree cell
- National park
- National forest





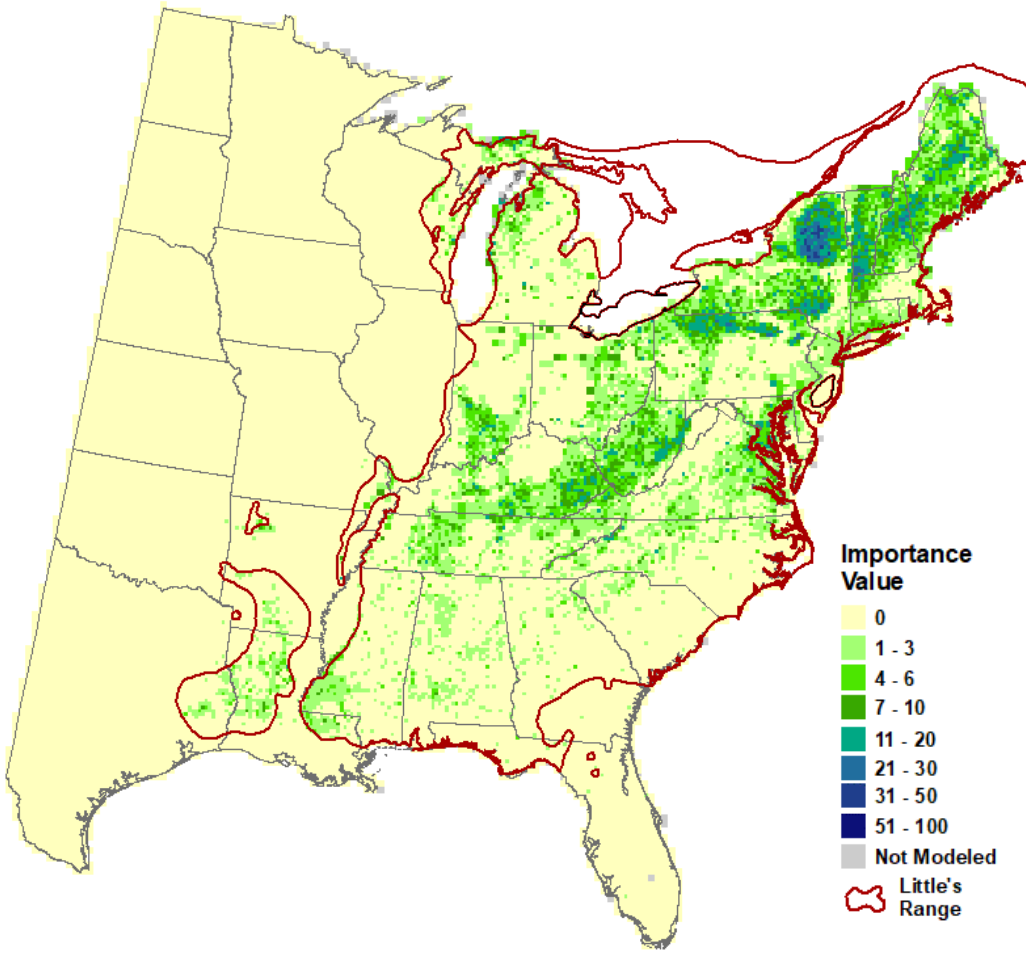




Step 3: Create Educational Resources

USFS Climate Change Tree Atlas summary by:

- Species' distribution changes



Step 3: Create Educational Resources

USFS Climate Change Tree Atlas summary by:

- Species' distribution changes
- Climate tolerance

Common Name	Scientific Name	ChngCl45	ChngCl85	Adap	Abund	Capabil45	Capabil85
red maple	Acer rubrum	Lg. dec.	Lg. dec.	High	Abundant	Good	Good
sugar maple	Acer saccharum	No change	Sm. dec.	High	Abundant	Very Good	Good
black cherry	Prunus serotina	Sm. dec.	Sm. dec.	Low	Abundant	Fair	Fair
green ash	Fraxinus pennsylvanica	No change	No change	Medium	Common	Fair	Fair
American elm	Ulmus americana	No change	Sm. inc.	Medium	Common	Fair	Good
yellow-poplar	Liriodendron tulipifera	No change	Sm. dec.	High	Common	Good	Fair
white ash	Fraxinus americana	Sm. inc.	Sm. inc.	Low	Common	Fair	Fair
northern red oak	Quercus rubra	No change	Sm. dec.	High	Common	Good	Fair
American beech	Fagus grandifolia	Sm. dec.	Lg. dec.	Medium	Common	Poor	Poor

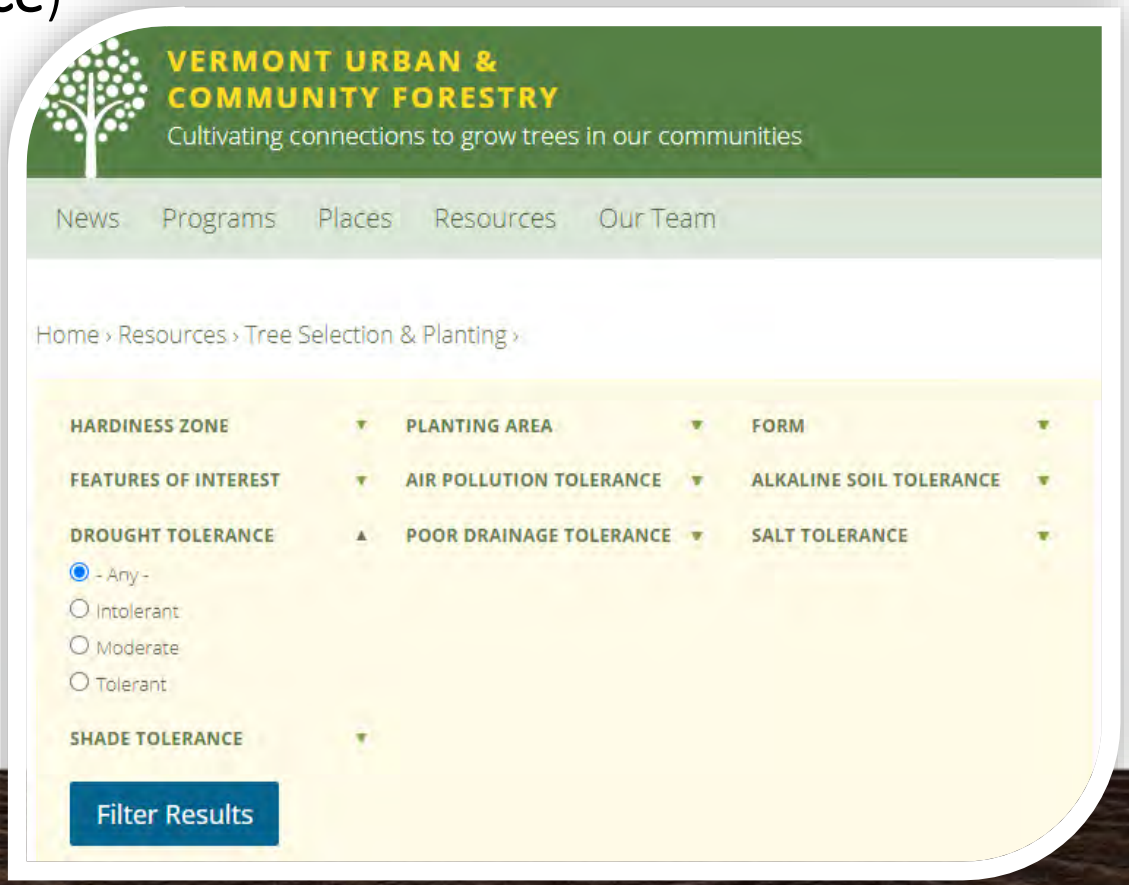
Step 3: Create Educational Resources

Outcomes:

1. Need for tree selection tool
    a. Filter trees based on criteria (tolerance to drought, soil, **climate tolerance**)

For immediate plant selection guidance:

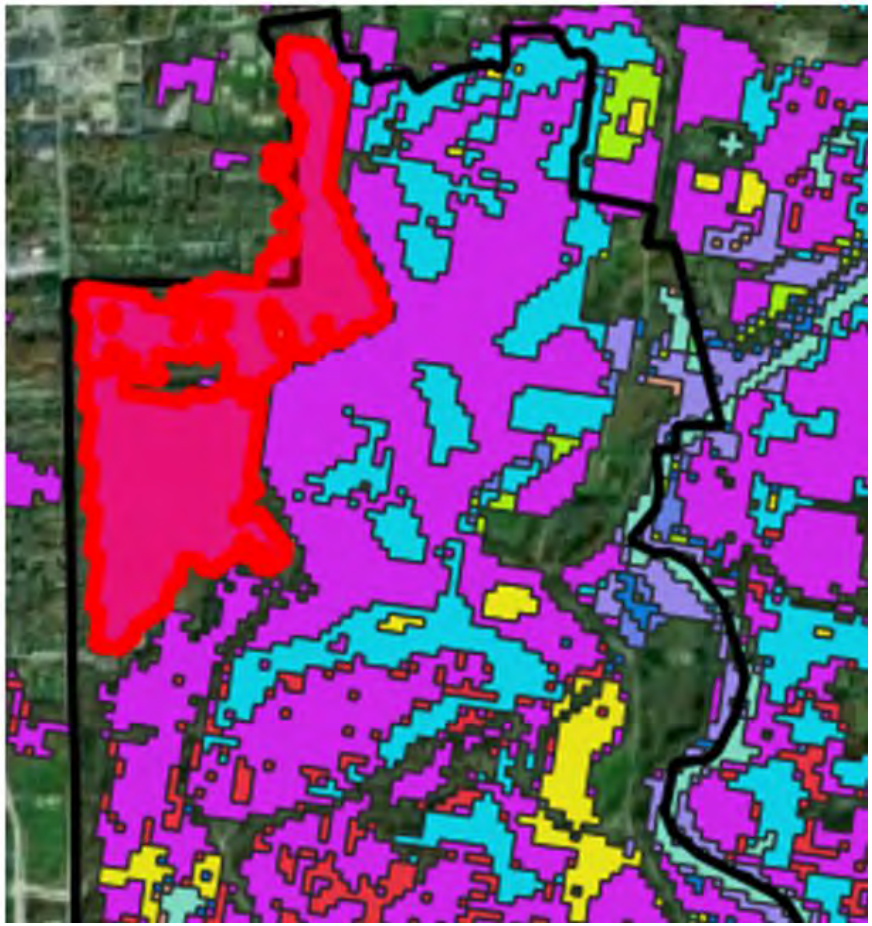
[Cleveland Metroparks Landscaping for Biodiversity with Ohio Native Plants]



Step 3: Create Educational Resources

Outcomes:

1. Need for tree selection tool
2. Plant community mapping product



Step 3: Create Educational Resources

Outcomes:

1. Need for tree selection tool
2. Plant community mapping product
3. Native plant nursery information

For immediate nursery guidance:

[Cleveland Metroparks Native Plant Nurseries]

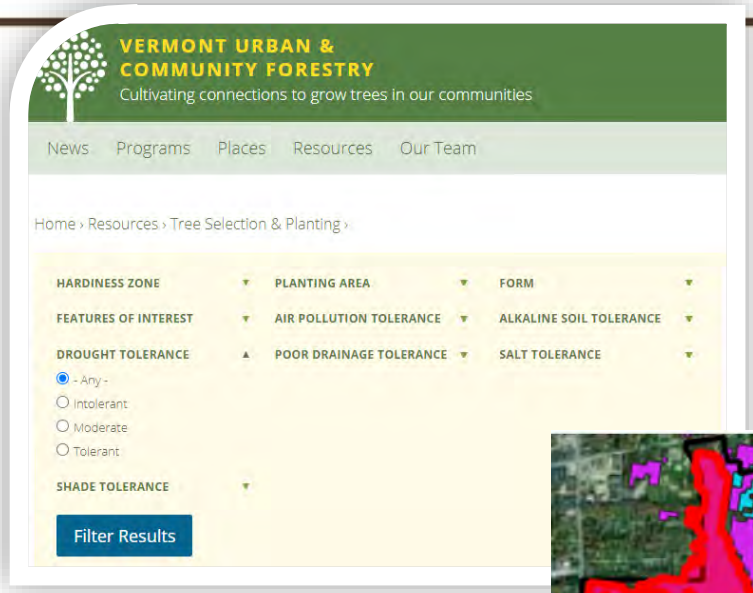
Step 3: Create Educational Resources

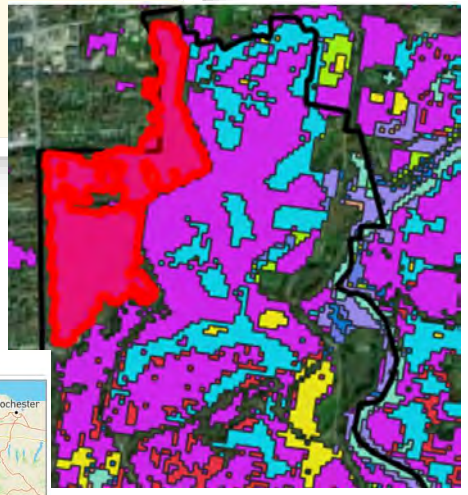
Timeline:

Request for proposal released: 1/3/2023

Submission deadline: 2/7/2023

Expect final product by end 2023





Takeaways – Climate Change

Climate change, species composition, and age structure are important factors in forest health

Carbon storage, sequestration and climate tolerance should be considered when planting trees

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Additional Resources

- The Nature Conservancy's Resilient Land Mapping Tool