

# Carbon Defense Strategies & Your Forest

**2<sup>nd</sup> annual NW NJ Rivers Conference**

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**RUTGERS**

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**Trees store and sequester carbon.**

**Proper tree maintenance and management practices can help to optimize these and other benefits in trees and forests.**

**Trees and forests can be used to address carbon defense goals.**



- NJ is Roughly 40% Forested
- That does not include the urban forest!



Distribution of  
Forest Land

Forest  
Nonforest



Processing note: This map was produced by linking plot data to MODIS satellite pixels (250 m) using gradient nearest neighbor techniques.

Figure 2. — Distribution of forest land, New Jersey, 2009.



The Urban Forest is all the trees and forests within a local jurisdiction. They include urban parks, street trees, landscaped boulevards, gardens, river and coastal promenades, greenways, river corridors, wetlands, nature preserves, shelter belts of trees, and working trees at former industrial sites.



Urban Forestry is the art, science, and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide society.



The *Urban Forest* is the sum of trees and associated vegetation, water, soil, and wildlife in man-made ecosystems.



*Urban Forestry* is the management (manipulation) of the urban forest to provide multiple, long-term benefits to humankind.

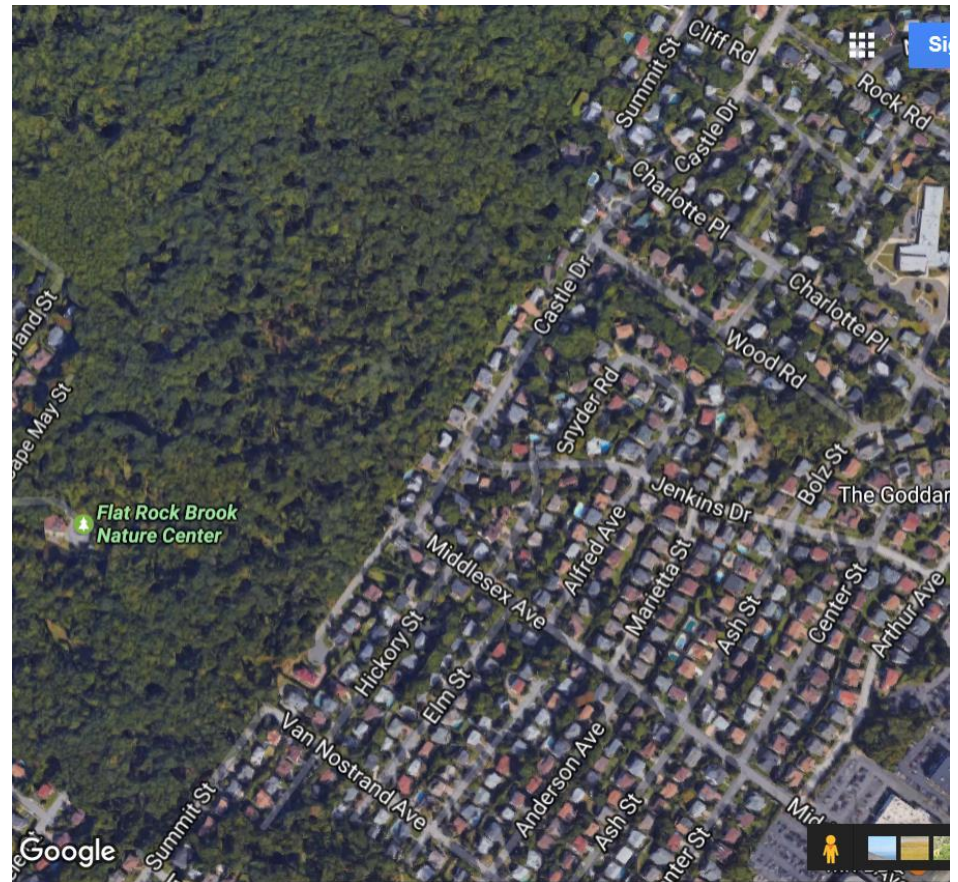


# Urban Forestry





# Arboriculture / Silviculture / Urban Forestry





## Carbon – Units of Measure

- Trees are approximately 50% Carbon (C) by mass
- Carbon (C) is an element
- Carbon Dioxide (CO<sub>2</sub>) is a compound
- $\text{CO}_2 = \text{C} * 3.67$  (by mass)
- 1 metric ton (tonne) = 1,000,000 grams = 1,000 kilograms
- 1 metric ton (tonne) = approximately 1.10 short tons (tons)
- 1 short ton C = approximately 3.67 short tons CO<sub>2</sub>





- **Carbon stored**

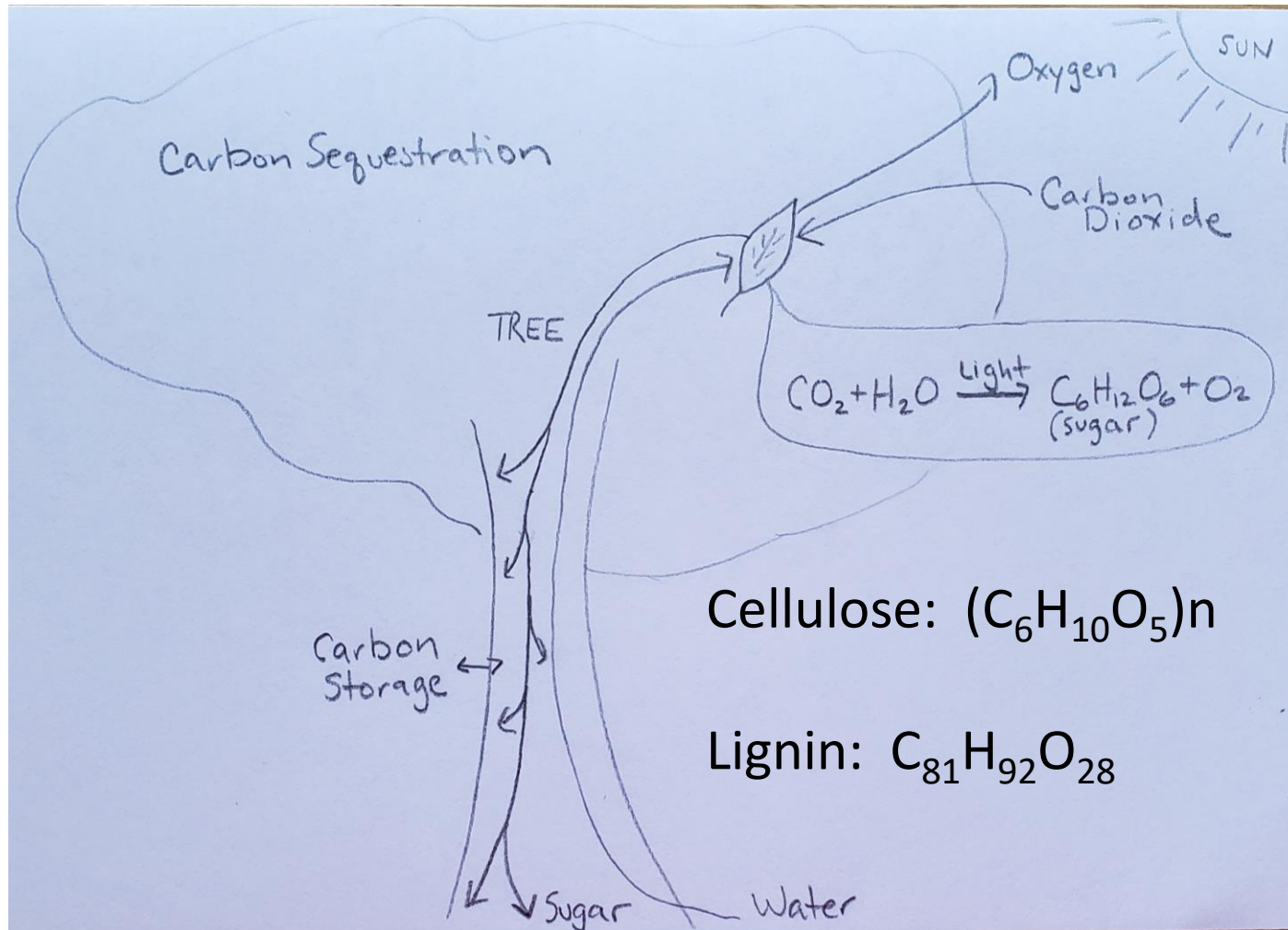
- The amount of carbon currently contained within a plant's woody tissue (above and below ground), including the amount of carbon within leaves for evergreen species.

- **Carbon sequestered**

- the amount of atmospheric carbon removed by trees.
- Process of capturing and storing atmospheric carbon dioxide
- Expressed as a rate (annual rate of sequestration).

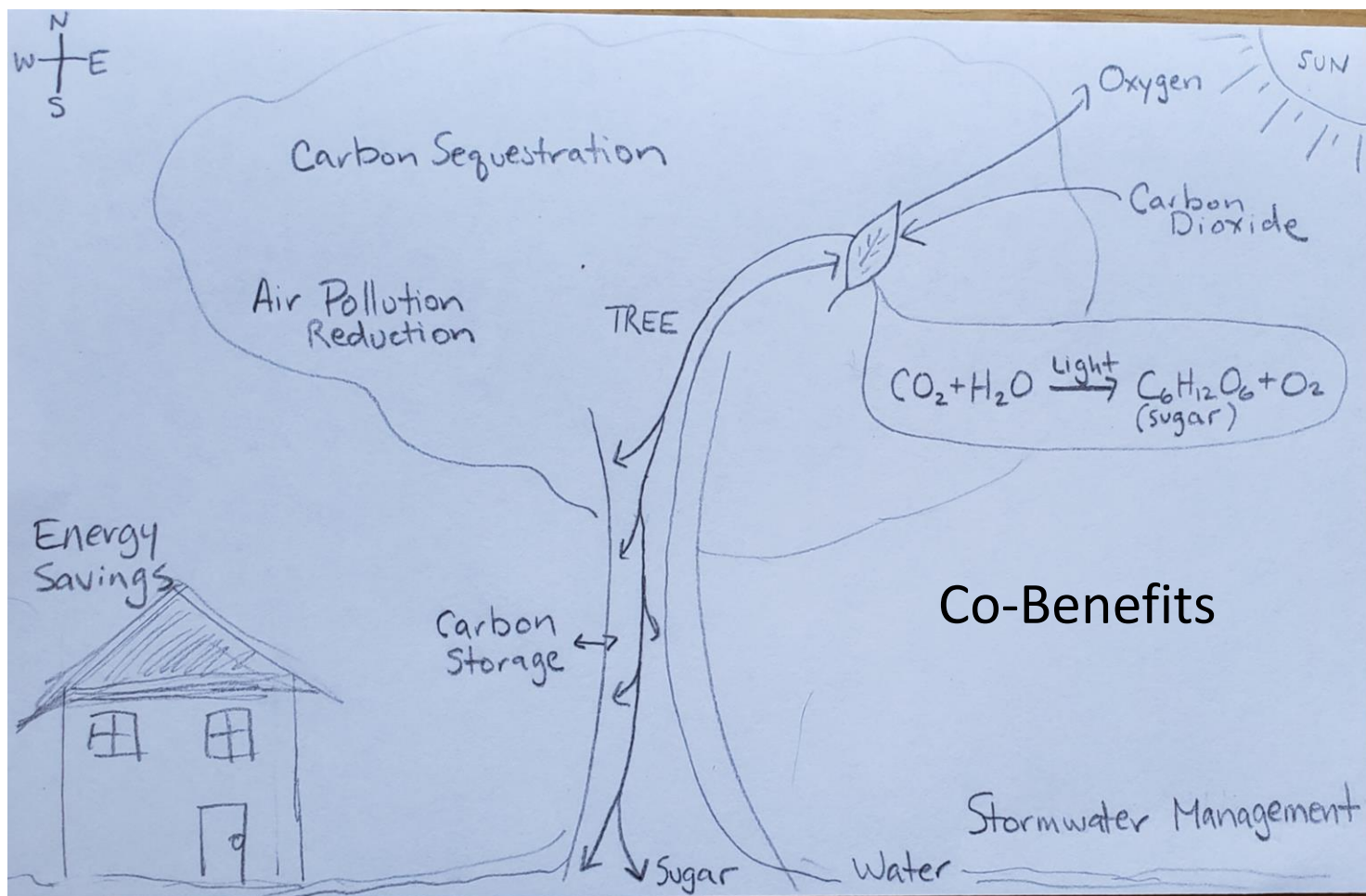


## How trees sequester and store carbon





# Carbon storage is not the only benefit from trees!





## How forests absorb carbon dioxide

Forests can function as carbon sinks, absorbing the climate-changing gas carbon dioxide from the atmosphere and storing it for long periods of time in trees and soil. How the carbon cycle works:

### ABSORPTION

#### Trees

Carbon is stored in trees and plants as they absorb carbon dioxide from the atmosphere to grow. Trees are very important because they live a long time and therefore store carbon for many years.

#### Soil

Decaying organic matter, such as dead trees, branches, plants and leaves transfer some carbon below ground to be held in the soil, which can hold it for long periods of time. Roots of living trees also transfer carbon to the soil.

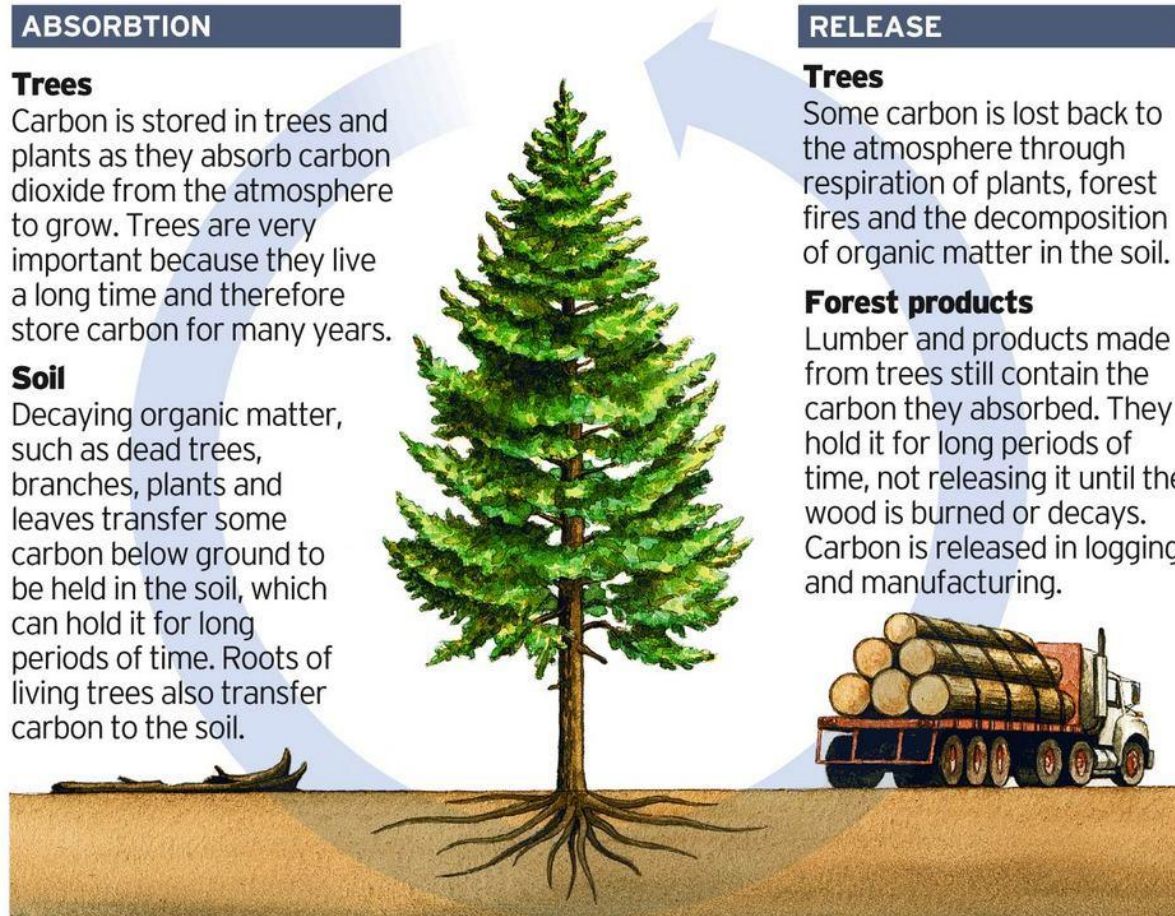
### RELEASE

#### Trees

Some carbon is lost back to the atmosphere through respiration of plants, forest fires and the decomposition of organic matter in the soil.

#### Forest products

Lumber and products made from trees still contain the carbon they absorbed. They hold it for long periods of time, not releasing it until the wood is burned or decays. Carbon is released in logging and manufacturing.





- **Carbon Pools (or Stocks)**

- A system that has the capacity to store or release carbon.
- Places where carbon is stored
- In forests, five main carbon pools are commonly recognized:
  - Above-ground biomass (live)
  - Below-ground biomass (live)
  - Dead wood
  - Litter
  - Soil organic matter

- **Carbon Flux**

- The amount of carbon moving from one pool to another over a specified period of time.
- Processes that transfer carbon from one pool to another



## Example: Great Lakes Forest

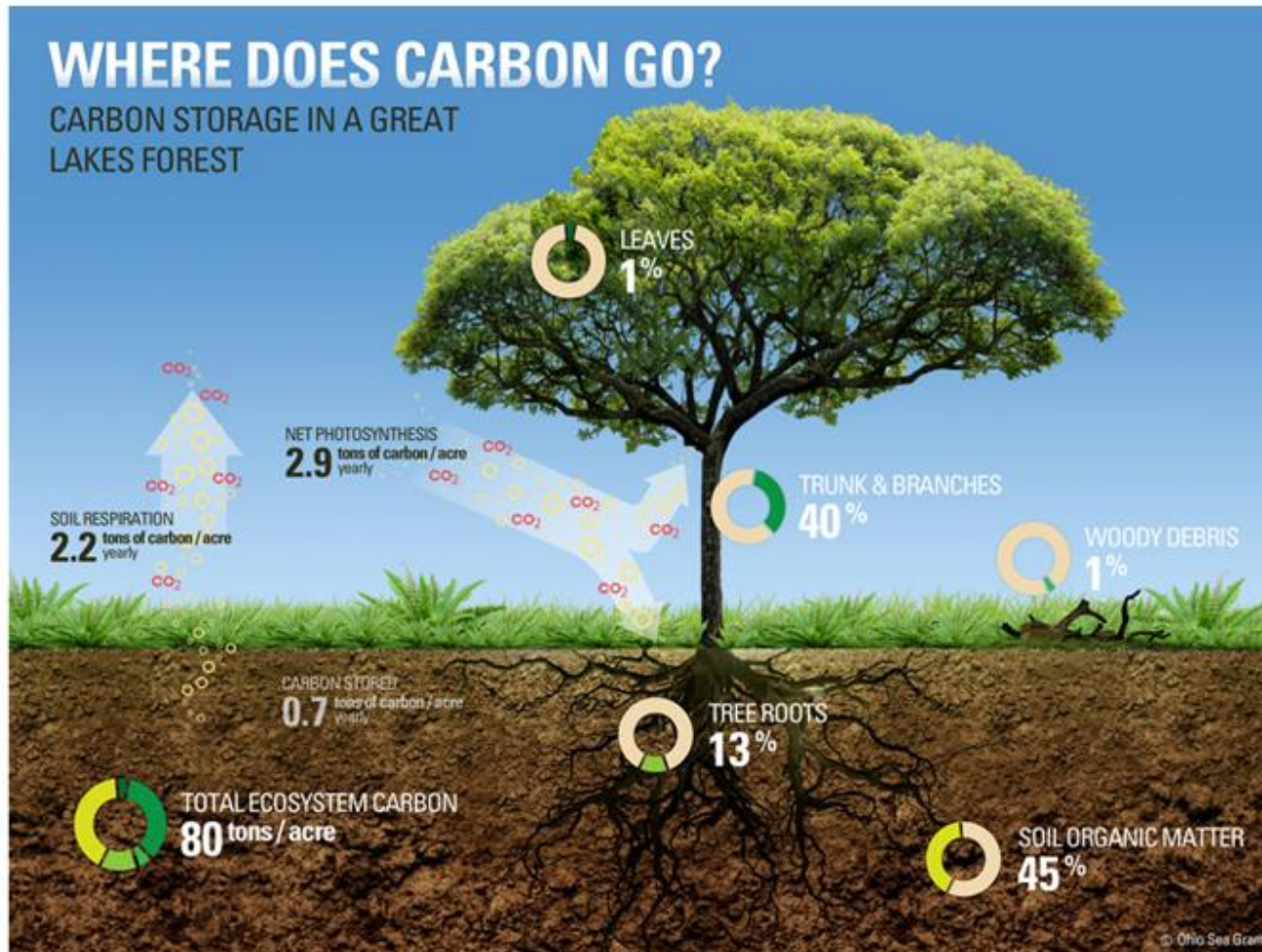


Image: <http://changingclimate.osu.edu/features/accounting-for-carbon/>



## Definitions (Carbon Terms)

- **Carbon Sink**
  - A negative source of CO<sub>2</sub> in the atmosphere via absorption and storing of carbon in vegetation, the atmosphere, and the ocean.
  - Carbon absorbed from the atmosphere
- **Carbon Source**
  - A positive source of CO<sub>2</sub> to the atmosphere.
  - Carbon released to the atmosphere through emissions
- **CO<sub>2</sub> Equivalent (CO<sub>2</sub>e)**
  - Describes different greenhouse gasses in a common unit. For any quantity and type of greenhouse gas, CO<sub>2</sub> equivalent signifies the amount of CO<sub>2</sub> which would have the equivalent global warming impact.



# Forestry Considerations

## Space and Time



## Definitions (Forestry Terms)

- Afforestation
  - Foresting land that was previously not forest
- Reforestation
  - Returning land that was once forest to forest again
- Ingrowth
  - Biomass growth within the forest comes from new trees; regeneration
- Accretion
  - Biomass growth within the forest comes from existing trees
- Avoided Conversion
  - Avoid tree loss to development or other land use conversion
- Avoided Emissions
  - Avoid rapid carbon release due to disease and death.



## Afforestation in the Urban Forest



**Royden Street, Camden  
2002 before trees**

New Jersey Tree Foundation

**NJ Tree Foundation Planting  
Royden Street, Camden  
2002 after trees**



New Jersey Tree Foundation



## **NJ Tree Foundation Planting Royden Street, Camden 2017**





## Optimizing Carbon Benefits of Trees

Bigger trees store more carbon

Healthier trees sequester more carbon



We need healthy trees!

We need big, healthy trees,  
where possible!

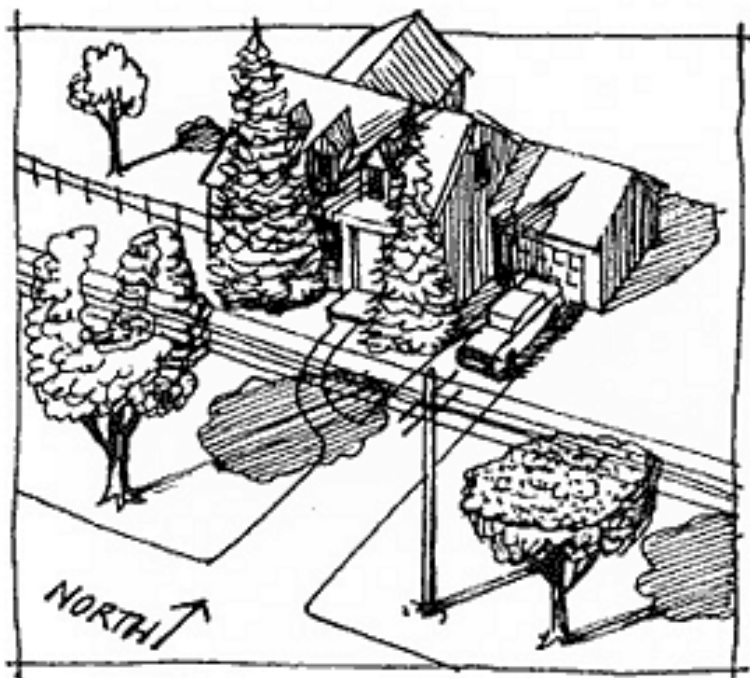


There is a huge cost to planting trees incorrectly, and choosing the wrong tree...

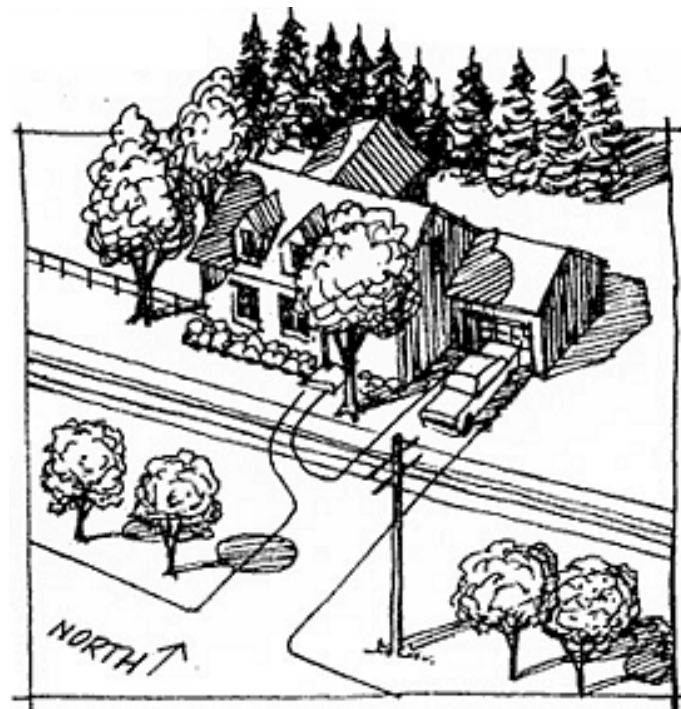




## Plant the Right Tree in the Right Place, the Right Way!



Wrong tree, Wrong place

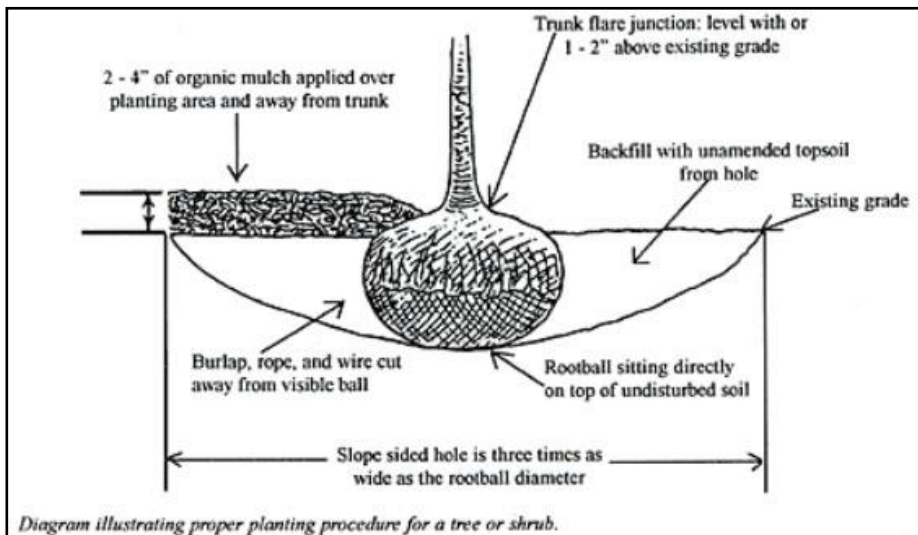


Right tree, Right place

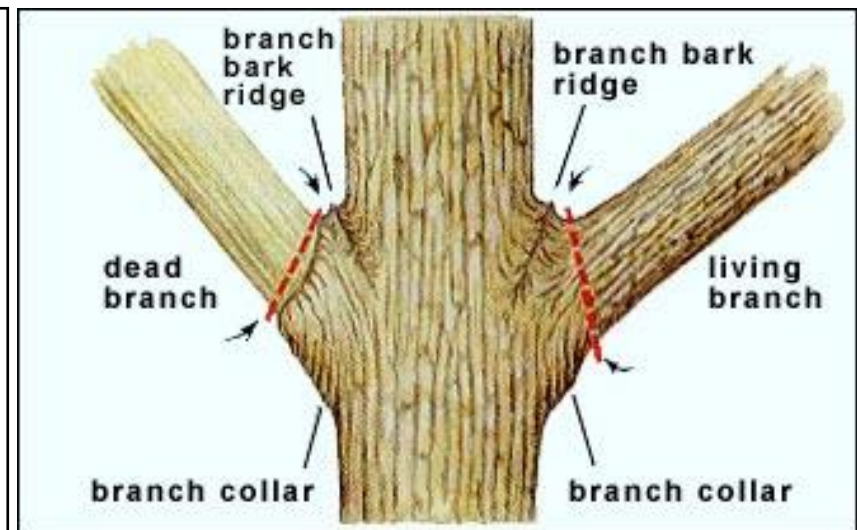
## Optimizing Carbon Benefits of Trees

- Proper tree maintenance and management practices can help to optimize carbon benefits in trees and forests

### Proper planting and mulching



### Proper pruning

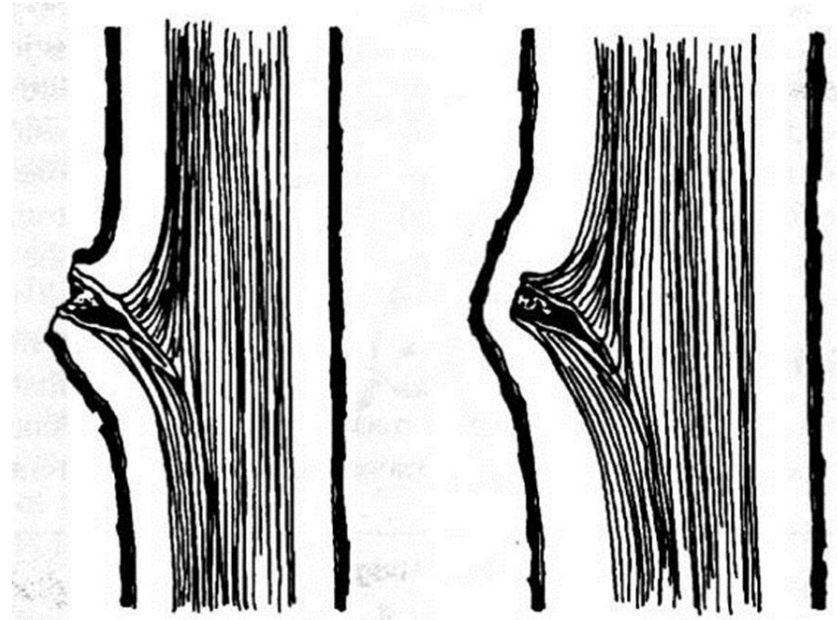


*Because Healthy Trees Sequester More Carbon*



## Trees don't heal their wounds

- Trees don't heal, they seal over their wounds with a new growth ring.
- Pruning cuts are wounds.
- Poor pruning will add stress to the tree as it diverts resources to try to seal the wound, making it more susceptible to insect and disease.



There is a huge cost to not pruning trees, or pruning incorrectly...



Photo credits: Dr. Chris Luley, ABC's Field Guide to Young and Small Tree Pruning



Failure to remove branches when trees are small can lead to extensive internal decay.

Decay means the tree is now a source instead of a sink – it is emitting carbon into the atmosphere. It is also very dangerous!



**Good Forest Management  
is  
Good Carbon Management**

# Diversity is the key!

- Composition
- Age
- Structure
- Strategies





## **Strategies for using trees and forests to manage carbon**

- Carbon defense
  - Keep existing trees healthy
  - Mitigate risk of existing trees and forests becoming carbon emitters
  - Tree maintenance / Forest Stewardship
- Carbon offense
  - Plant trees
  - Plant forests
  - Right tree, right place, right way
  - Tree maintenance / Forest Stewardship

# Carbon Defense in the “traditional” forest



**Warren Grove Wildfire**



**Beetle  
Outbreak**



## Strategies: Species Diversity

- To insulate against widespread tree losses due to insect and disease
- Also improves biodiversity through habitat
- Also is more interesting (opinion 😊)



Emerald Ash Borer



Bacterial Leaf Scorch



Spotted Lanternfly

## Strategies: Age Diversity (relative age distribution)

- To ensure continuity of canopy cover (which will sequester carbon).
- To enable consistent management.
- To avoid catastrophic failures (and therefore avoid emissions).

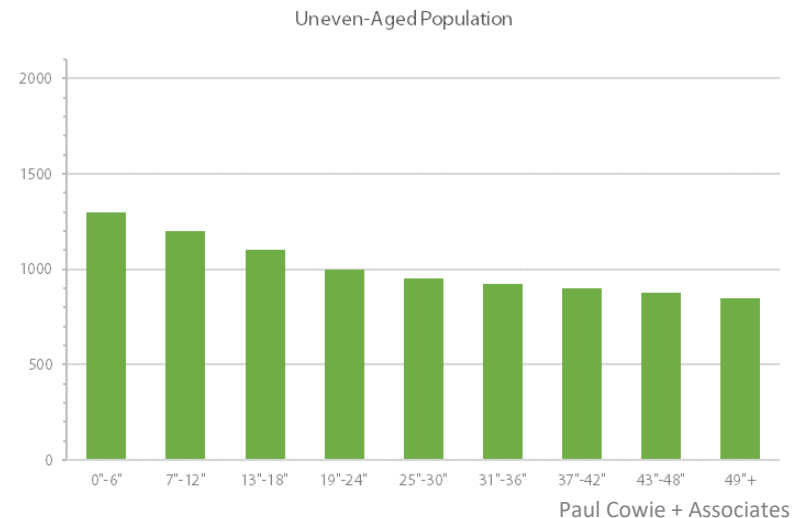
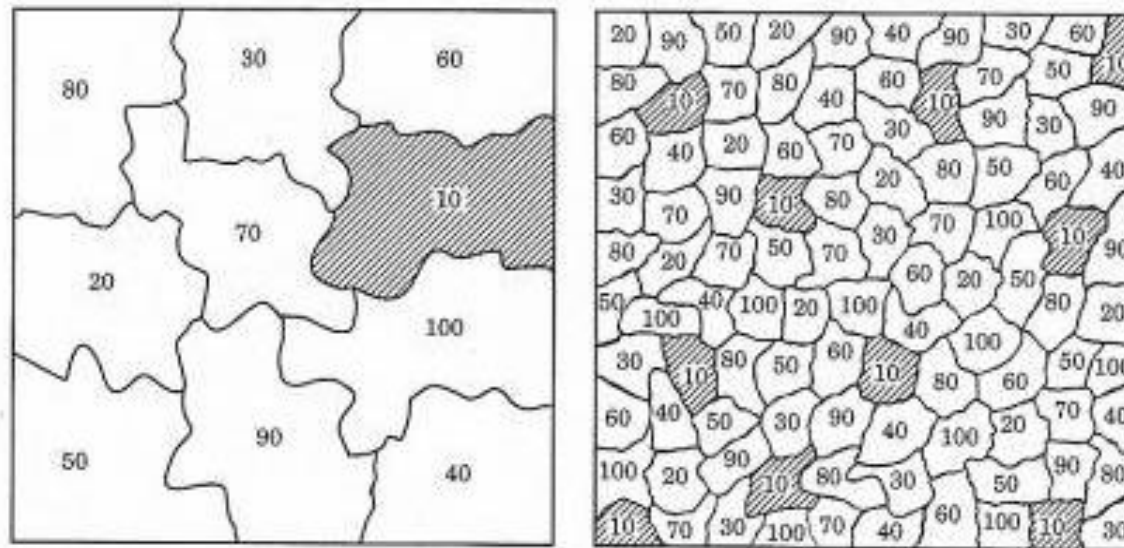






Photo credit Paul Cowie + Associates



(b)

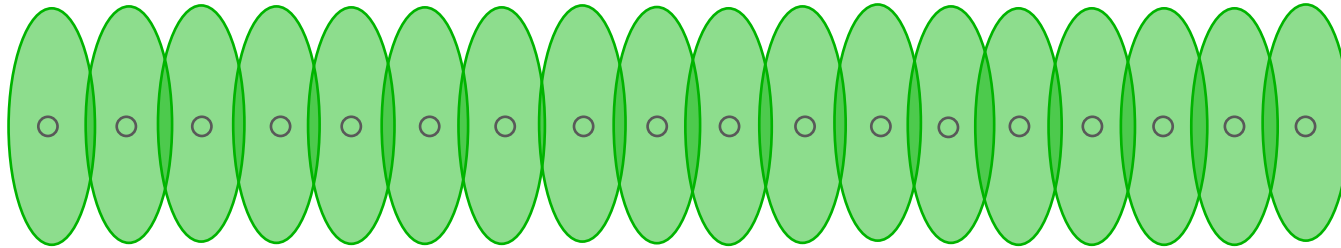
*Forest level:* Both drawings represent 1,000-acre forests with balanced age-class distributions, as indicated by the age shown for each stand. The youngest stands are shaded, indicating the areas where distinct edge habitat exists. The use of 10-acre stands rather than 100-acre stands disperses edge habitat throughout the forest area.



# Strategies: Stocking / Density

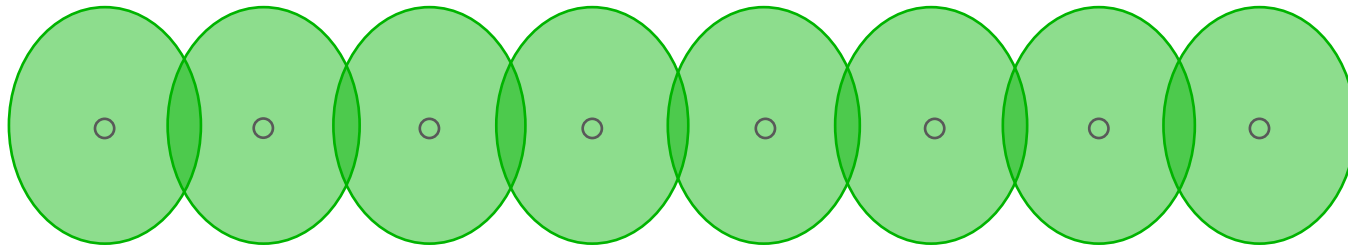
Diagrams from Paul Cowie + Associates

20' – 25' spacing



Crowding creates stress, trees will be less healthy, can't grow to full potential. Also, higher costs for purchase, planting, maintenance, and eventual removal

35' – 40' spacing



Here the same amount of canopy cover is achieved with about half the number of trees. These trees will be healthier, grow bigger, and cost less.

# Proper Planting

**Top of  
root ball**



**Root  
Flare**

New Jersey Tree Foundation



New Jersey Tree Foundation

## Proper Mulching and Watering



# Young Tree Pruning: Central Leader



## Young Tree Pruning: Correct Codominant Stems

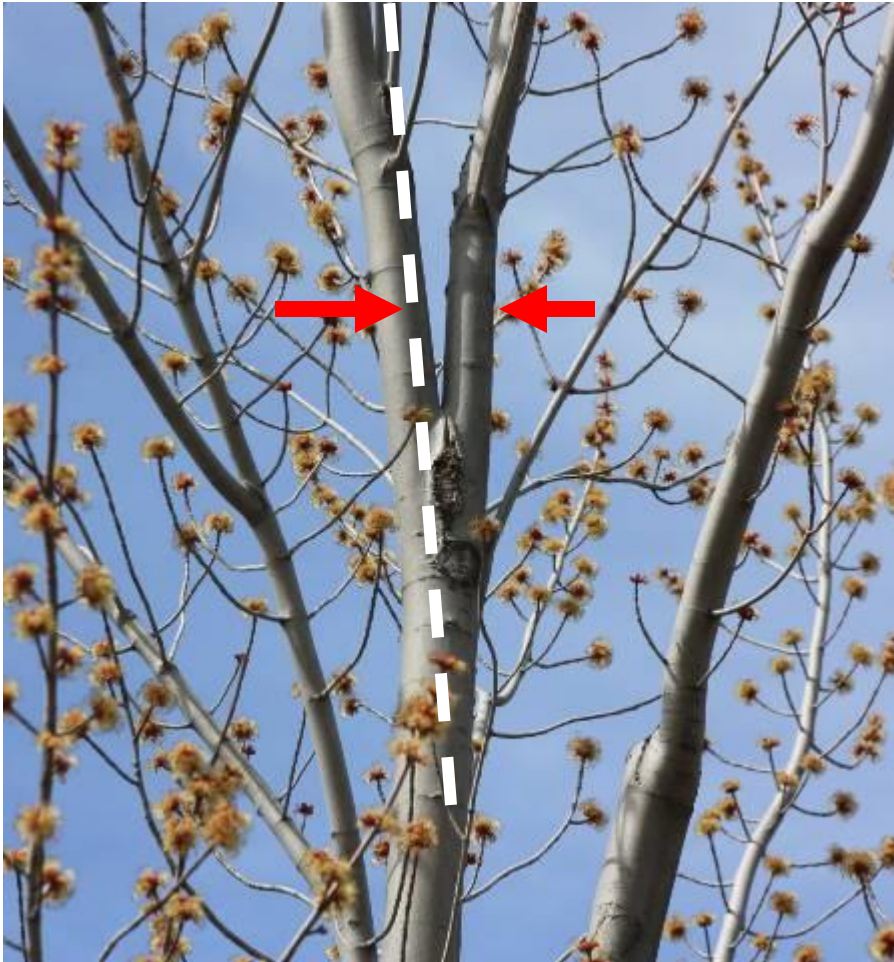


Photo credits: Dr. Chris Luley, ABC's Field Guide to Young and Small Tree Pruning



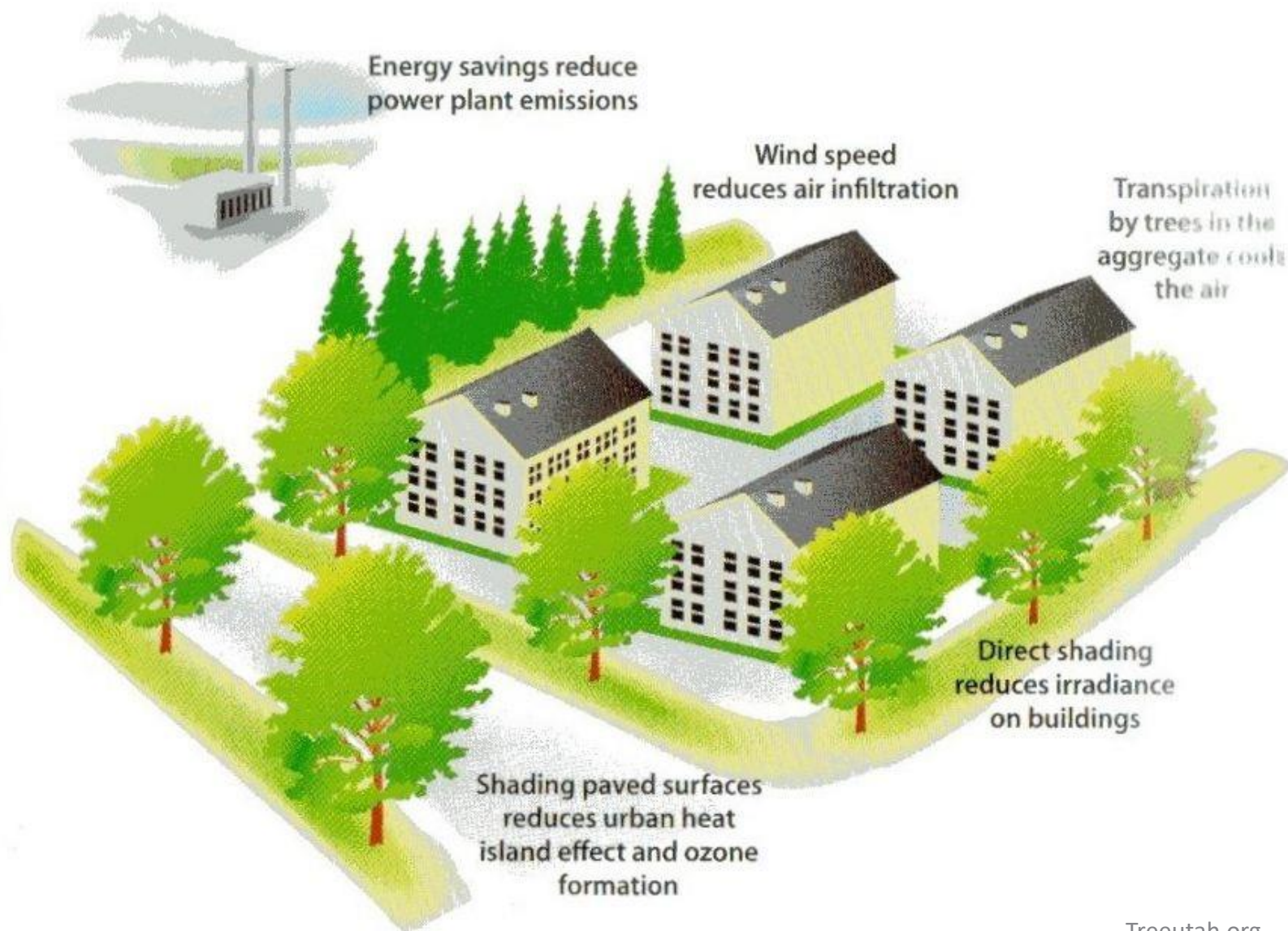




## Strategies: Right Tree, Right Place







## Strategie: Diversity of Strategies

We should employ all the tools we have...

Every tree is different

Every forest is different

Every situation is different

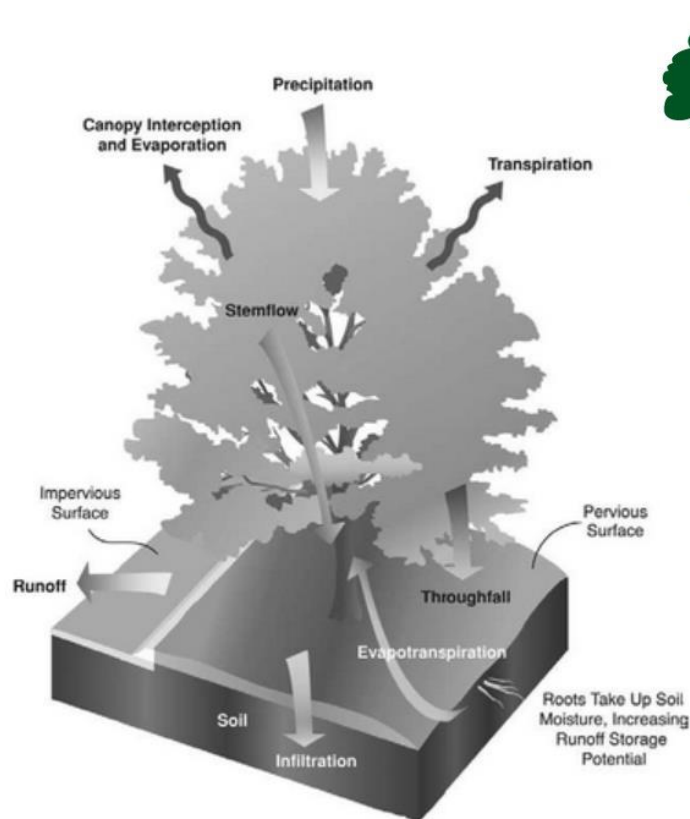
Forests are dynamic systems



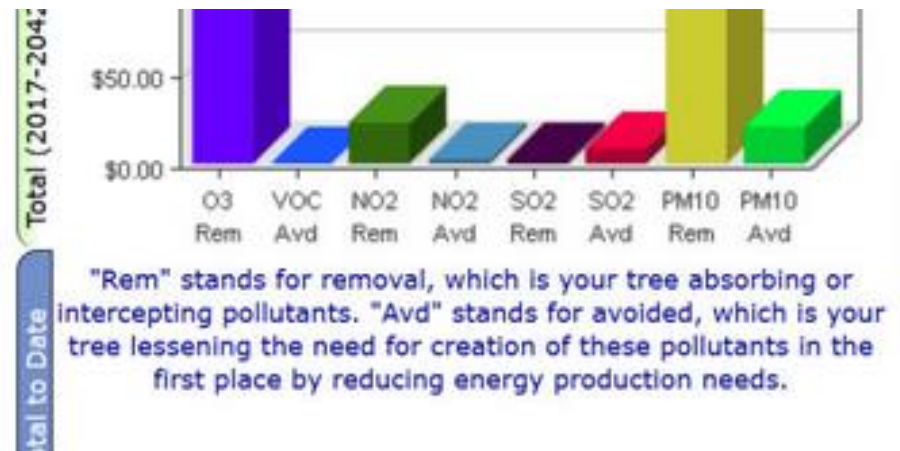


## Carbon isn't the only thing...

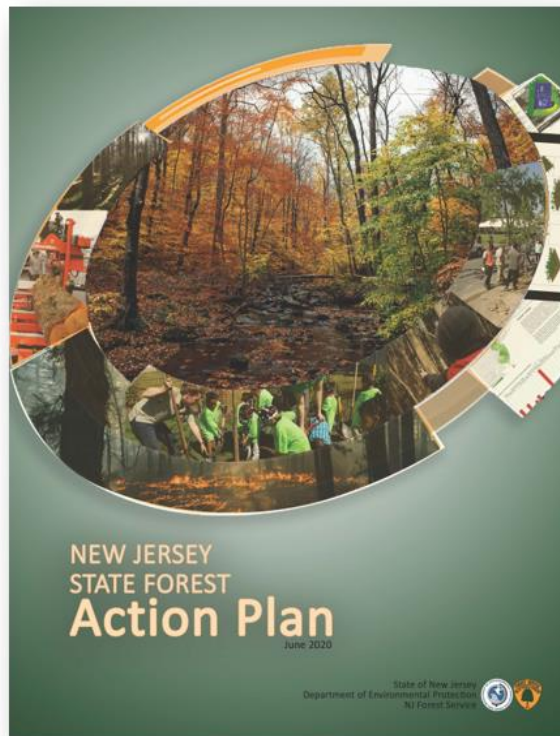
- There are other reasons to have trees and forests! (co-benefits)



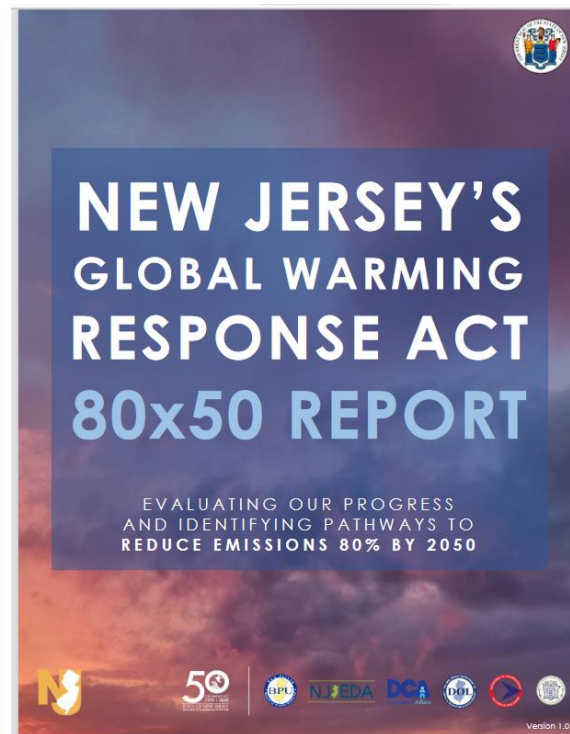
Stormwater Management  
Air Quality Improvement  
Energy Savings  
Pollution Avoided



## Some good things to know about:



<https://njparksandforests.org/forest/njsfap/>



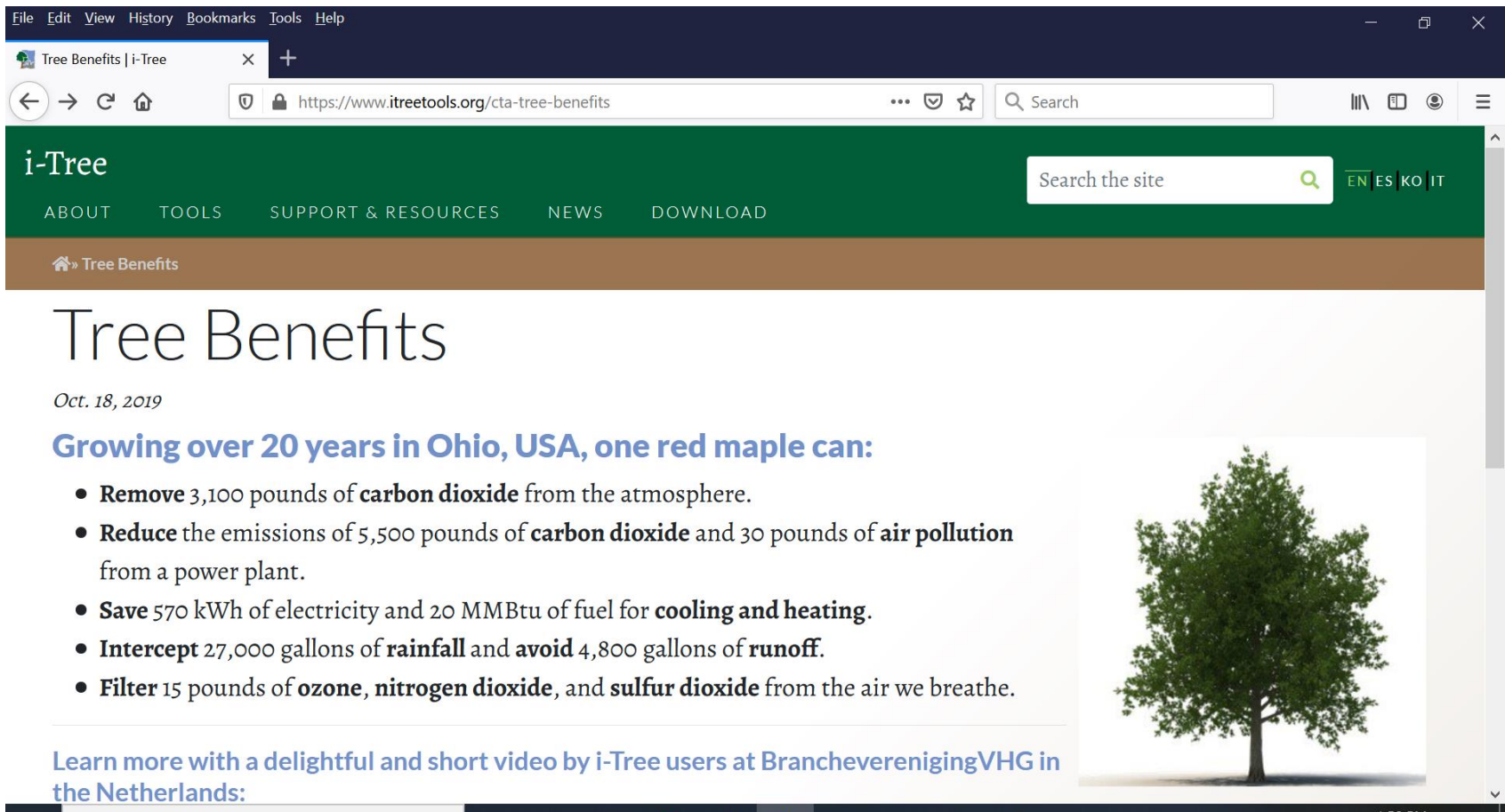
<https://www.nj.gov/dep/climatechange/docs/nj-gwra-80x50-report-2020.pdf>



<https://www.nj.gov/rggi/docs/rggi-strategic-funding-plan.pdf>



## i-Tree (www.itreetools.org)



The screenshot shows a web browser window with the URL <https://www.itreetools.org/cta-tree-benefits>. The page has a green header with the 'i-Tree' logo and a search bar. Below the header is a brown navigation bar with the text 'Tree Benefits'. The main content area is white and features the title 'Tree Benefits' in a large font. Below the title is the date 'Oct. 18, 2019' and a blue heading 'Growing over 20 years in Ohio, USA, one red maple can:'. A list of five bullet points follows, detailing the benefits of a red maple tree. To the right of the text is a 3D rendering of a mature red maple tree. At the bottom, there is a blue link to learn more.

File Edit View History Bookmarks Tools Help

Tree Benefits | i-Tree

https://www.itreetools.org/cta-tree-benefits

i-Tree

Search the site

ABOUT TOOLS SUPPORT & RESOURCES NEWS DOWNLOAD

Tree Benefits


# Tree Benefits

Oct. 18, 2019

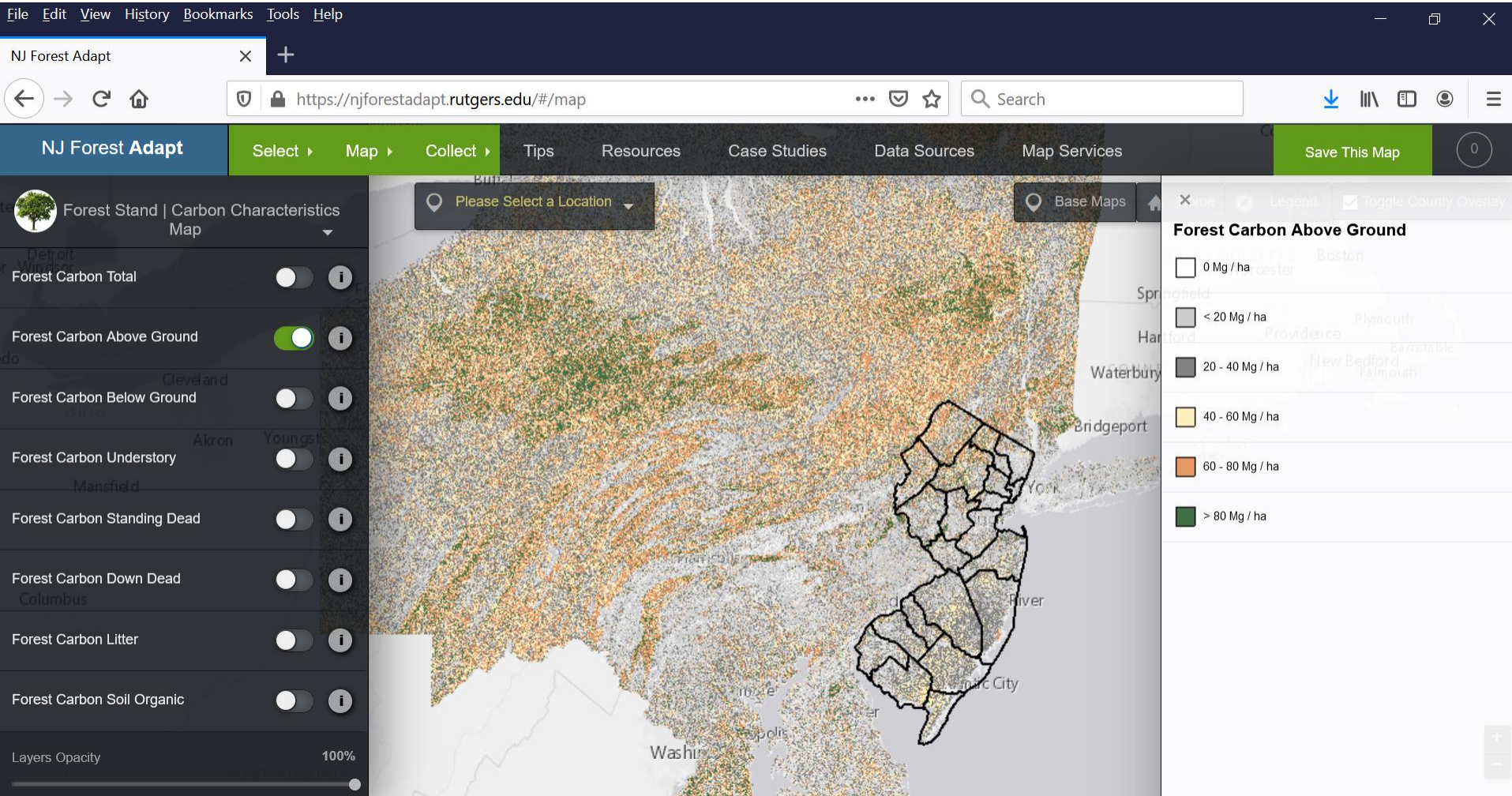
## Growing over 20 years in Ohio, USA, one red maple can:

- **Remove** 3,100 pounds of **carbon dioxide** from the atmosphere.
- **Reduce** the emissions of 5,500 pounds of **carbon dioxide** and 30 pounds of **air pollution** from a power plant.
- **Save** 570 kWh of electricity and 20 MMBtu of fuel for **cooling and heating**.
- **Intercept** 27,000 gallons of **rainfall** and **avoid** 4,800 gallons of **runoff**.
- **Filter** 15 pounds of **ozone**, **nitrogen dioxide**, and **sulfur dioxide** from the air we breathe.

Learn more with a delightful and short video by i-Tree users at BrancheverenigingVHG in the Netherlands:



# NJ Forest Adapt (njforestadapt.rutgers.edu)





# People are part of the Urban Forest

- We need trees where people are in order to derive direct benefit to human populations.



NJ Tree Foundation Plantings

# A Healthy Forest is no Accident

- Think at least one level beyond your management
- Trees are infrastructure
- Consider ecological function
- Carbon isn't the only thing
- Consider the carbon footprint of planting, maintenance, and tree removal activities
- Invest in your young trees





# Carbon Defense Strategies & Your Forest

**Thank you! Any Questions?**



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