Urban Tree Health Challenges and Urban Maple Condition in New Haven

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IN A NUTSHELL…

We need urban trees!

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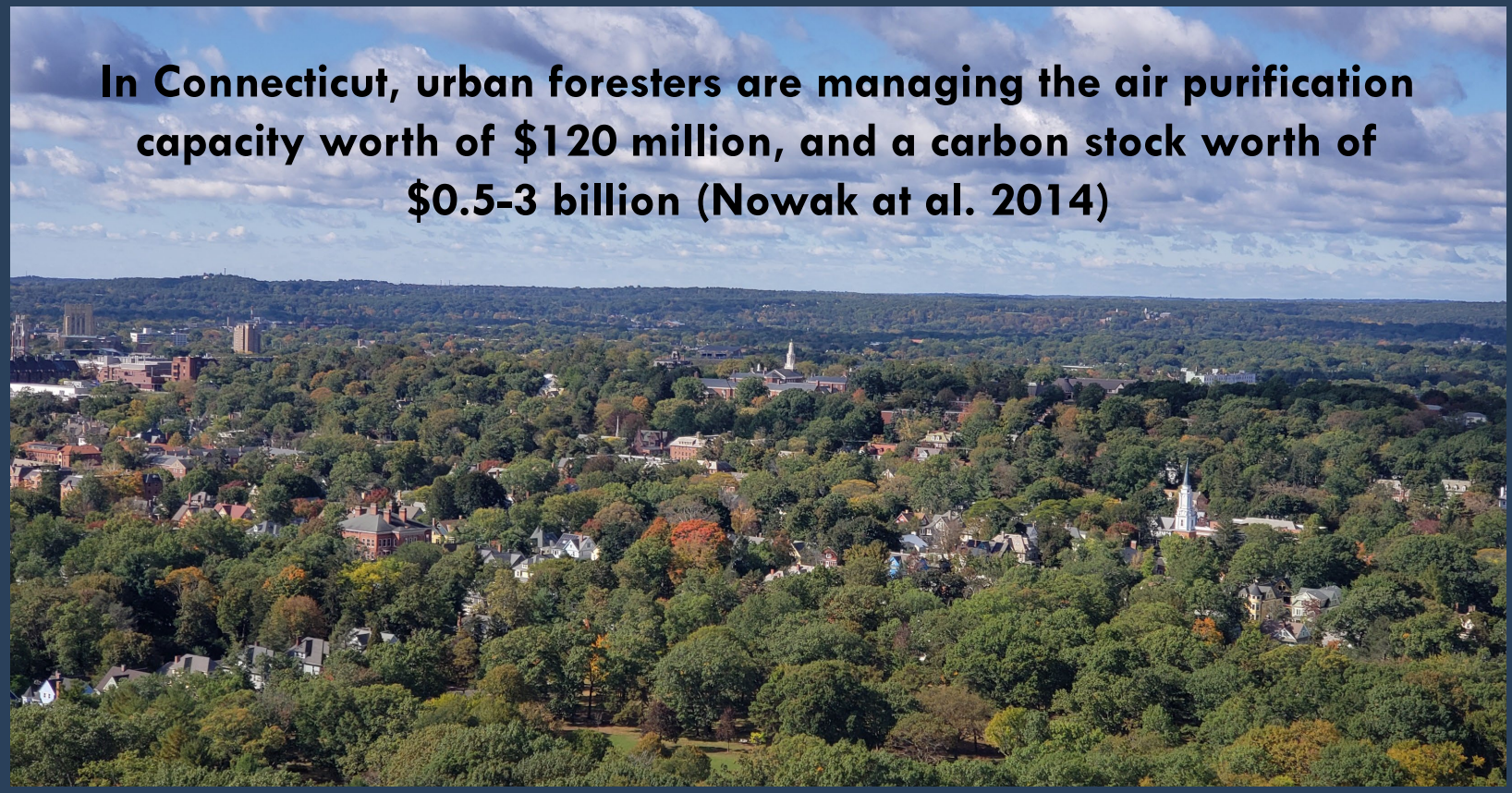
SOCIETAL VALUE OF URBAN FORESTS

- Urban forestry and tree care sector in Midwest and Northeastern states (Parajuli et al. 2022, Urban Forestry & Urban Greening 69):
  - Employs 375,000 people, Creates $17.6 billion in industry output, $16 billion payroll



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URBAN FORESTS IN CONNECTICUT

- **In Connecticut, 88% of people live in urban areas**
  - Nationally 83%
- Urban population in the US predicted to reach 89% by 2050 → urban forests are in high demand
- Connecticut is the local and national leader in urban tree cover with 62% UTC

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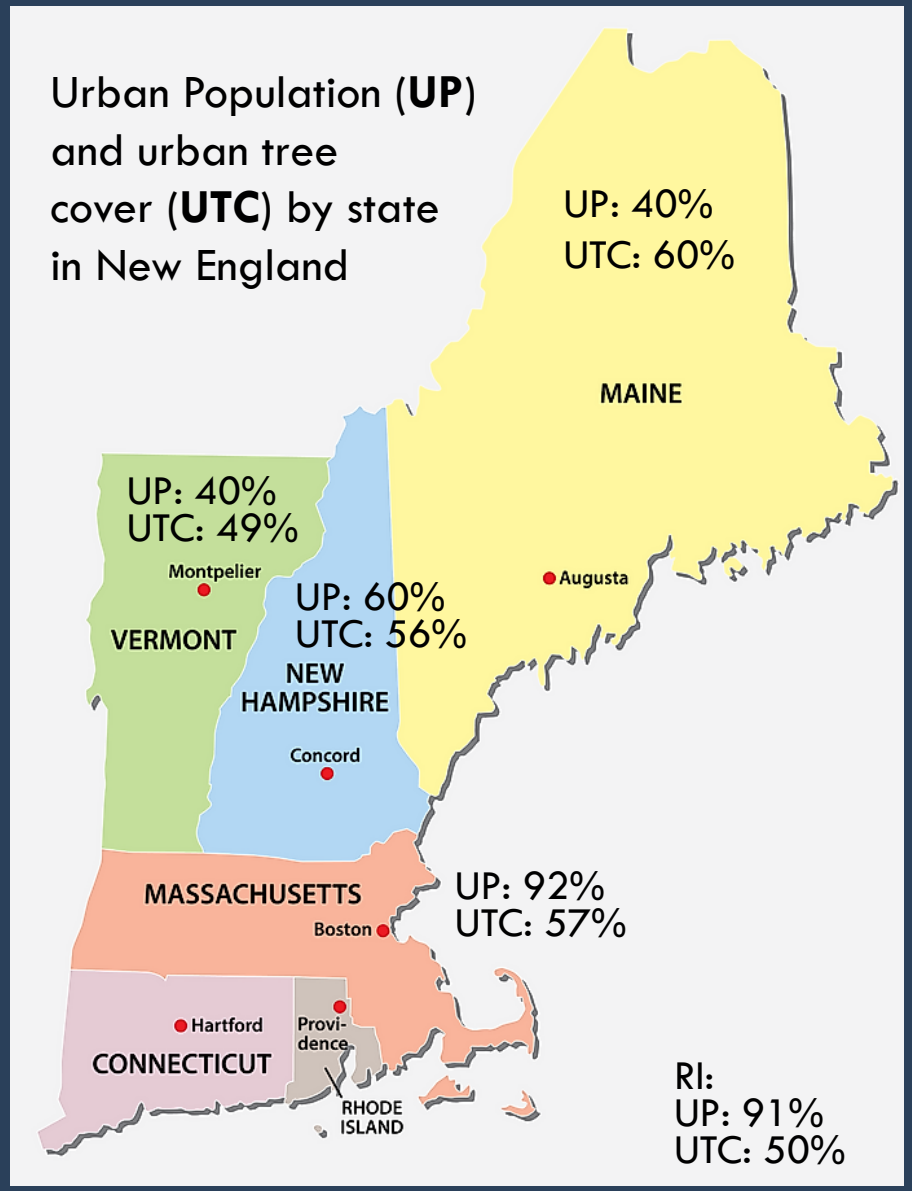
CT
UP: 88%
UTC: 62%

However…

Nowak & Greenfield 2017, J.For. 116:2



TREES AND PEOPLE: ENVIRONMENTAL EQUITY

- Across 5000+ US urban communities with 167 million people, urban canopy cover is lower in low-income areas
- In Connecticut, high disparity in urban tree cover between low and high-income blocks in Stamford and Bridgeport
  - 50% difference in tree cover
  - 7.2°F difference in summer temperatures

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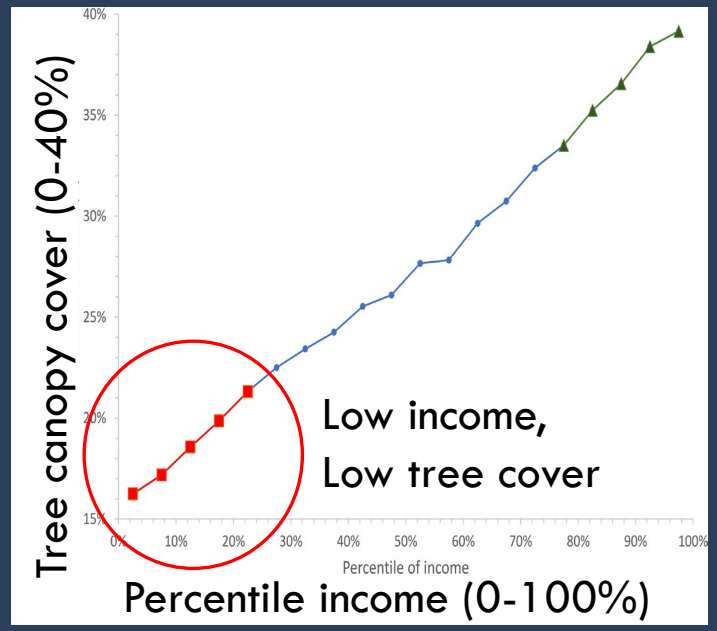
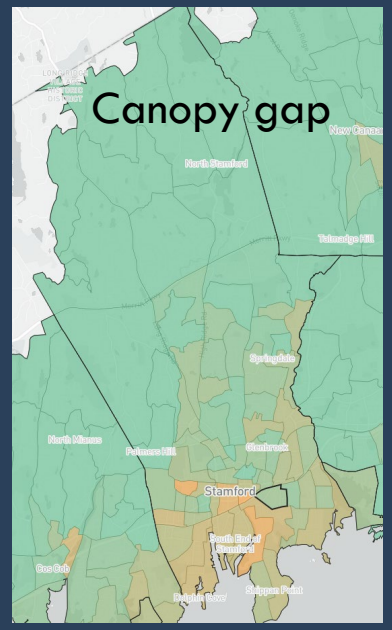
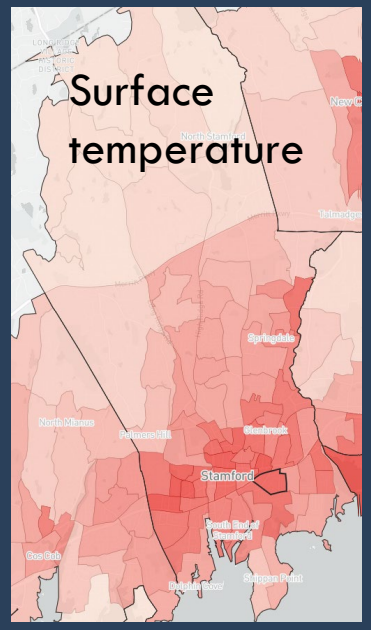
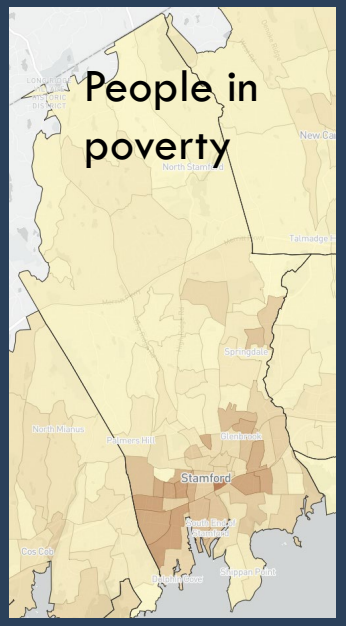




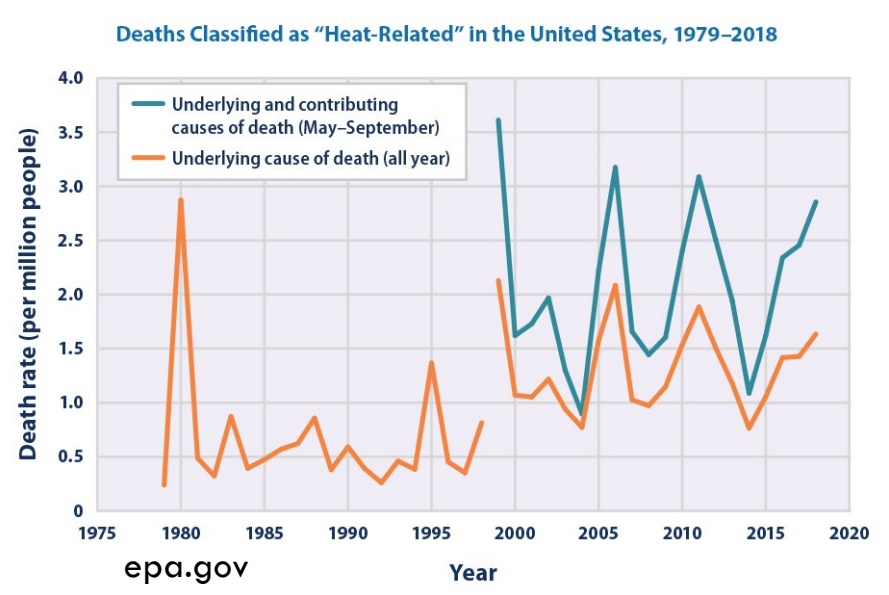




McDonald et al. 2021. PLoS One 16:4.

www.treeequityscore.org

CONSEQUENCES OF UTC DISPARITY



Opinion: The New York Times,
Ian Leahy and Yaryna Serkez.

- Heat stroke the no. 1 weather-related killer in the US (associated with12,000 deaths/y)
  - Connecticut: 7.2°F difference in summer temperatures between Bridgeport and Stamford
- Baltimore: The current tree cover estimated to prevent 543 deaths/y due to heatstroke
- With climate change, UHI will amplify in areas with low UTC and low tree equity score

Sinha et al. 2021. Ecological Modelling 449.

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TREE EQUITY SCORE

Tree Equity Score

A map of tree cover in any city in the United States is too often a map of race and income. This is unacceptable. Trees are critical infrastructure that every person in every neighborhood deserves. Trees can help address damaging environmental inequities like air pollution.

The score evaluates data from each neighborhood's:

- Existing tree canopy
- Population density
- Income
- Employment
- Surface temperature
- Race
- Age
- Health

These metrics are combined into a single score between 0 and 100. A score of 100 means that a neighborhood has achieved Tree Equity. To learn more, visit our methodology page.

- Tree cover disparity evaluated based on **tree equity score**
- Helps to guide resources to areas where trees are most needed
- Learn more: treeequityscore.org

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ARE TREES THE ANSWER?

- The Intergovernmental Panel on Climate Change (IPCC) report list carbon storage within cities and people-centered urban design as strategies for urban areas to mitigate the impacts of climate change

- IPCC report mentions forests or forestry >2000 times

- Challenge: How do we best maintain this green infrastructure in a changing climate and in these challenging conditions?

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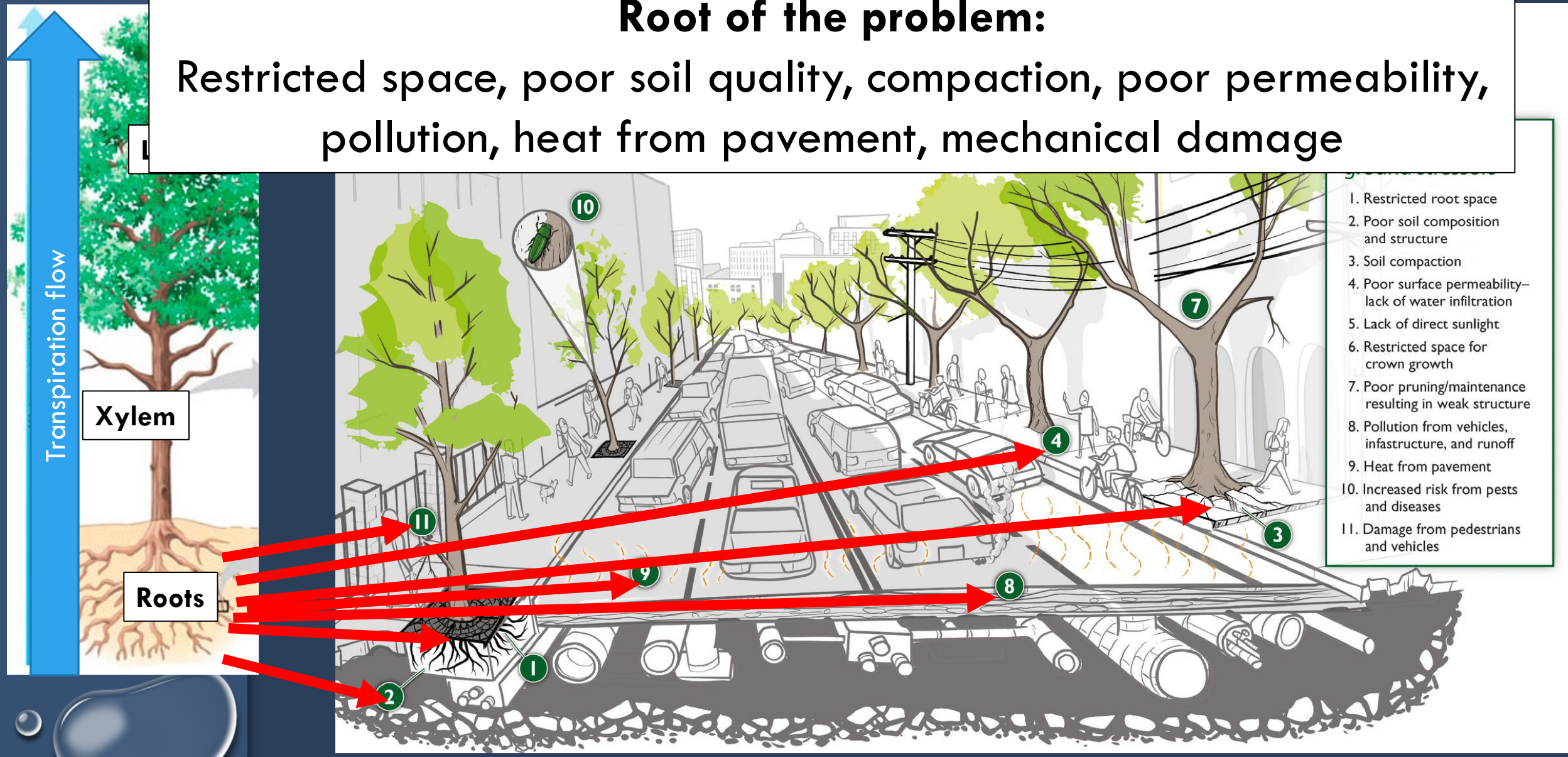
STRESS & URBAN TREES

Root of the problem:

Restricted space, poor soil quality, compaction, poor permeability, pollution, heat from pavement, mechanical damage



URBAN TREES ARE STRESSED

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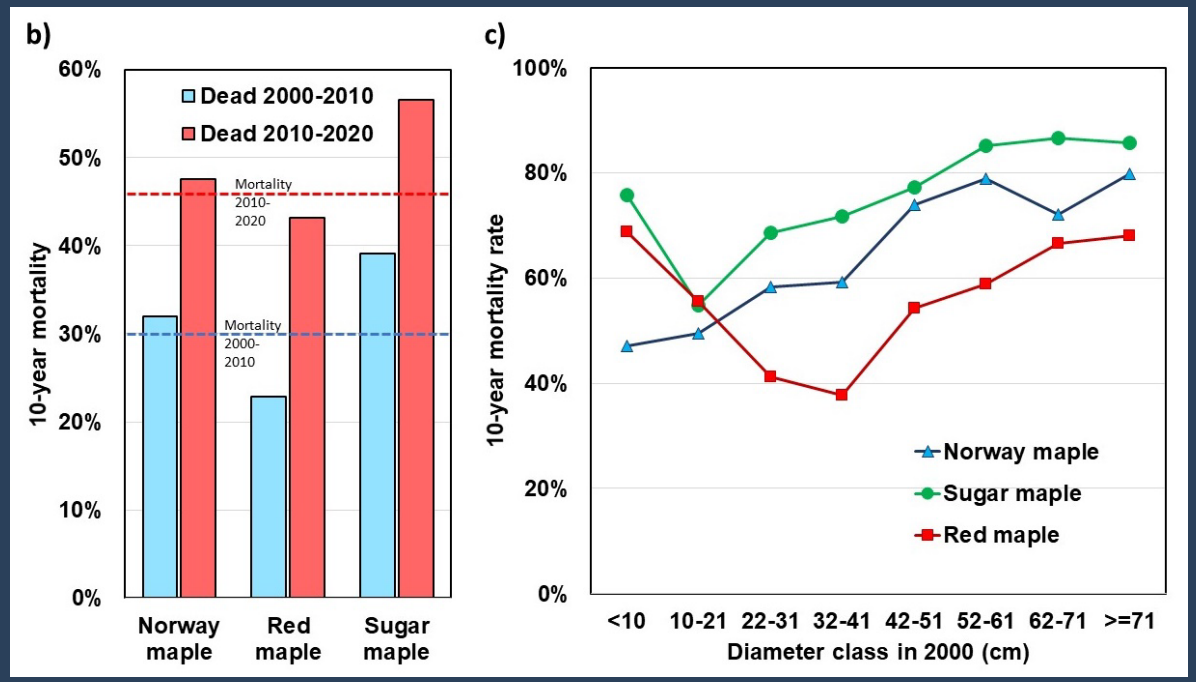
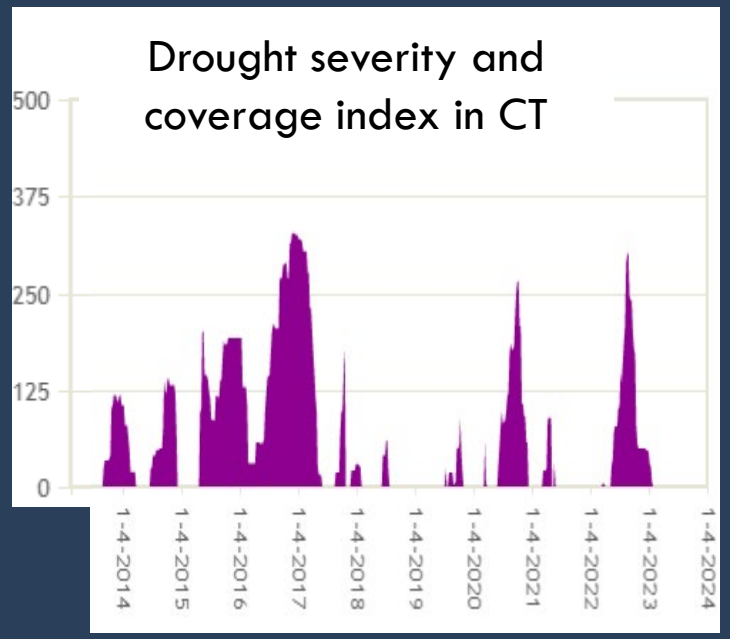
- CAES Survey in New Haven 2010-2020 (Dr. Jeff Ward):
  - Maple mortality in New Haven has increased from 30% to 45%
  - 75% of young red maples die (!) (increase of 46%)
  - Causal factors unclear

Data:
Dr. Jeffrey Ward, CAES.

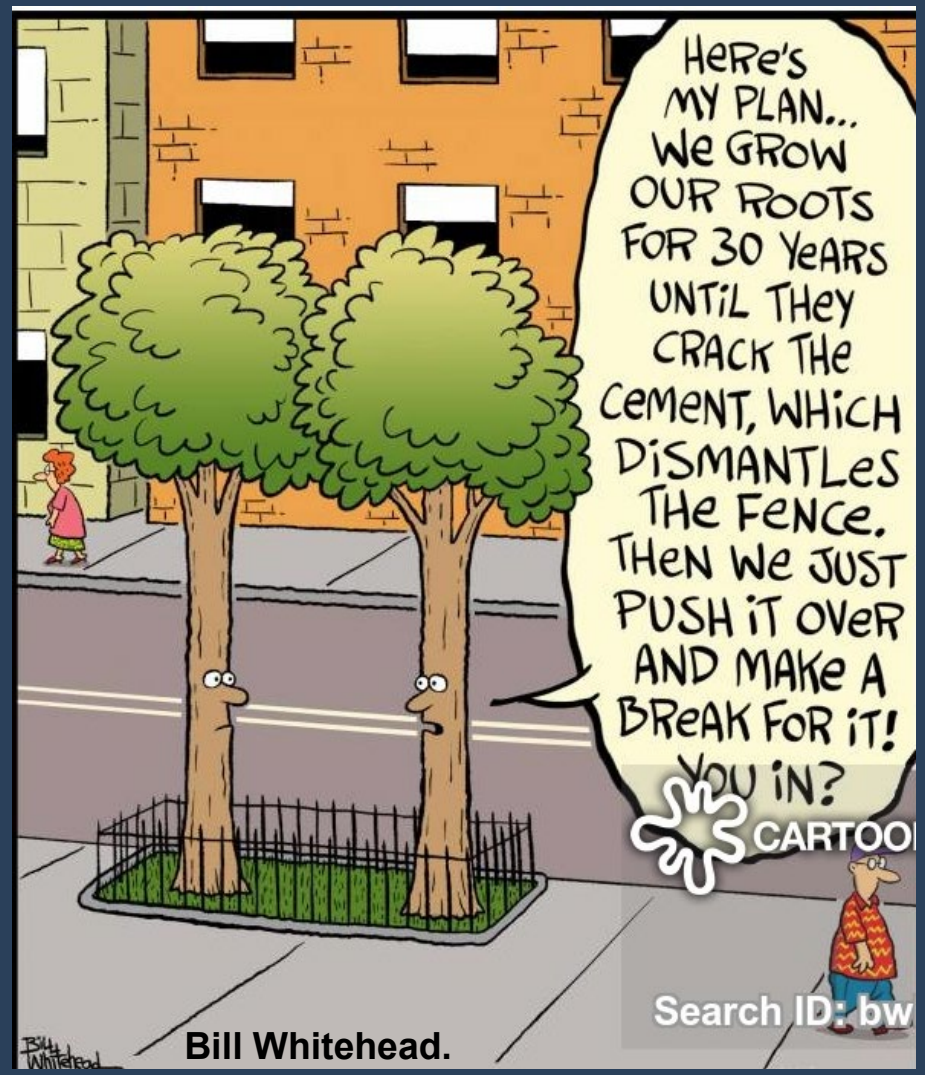
Justin Alamo, Plant Health Fellows Intern 2020.





URBAN TREES & DROUGHT

- Soil environment in urban settings
  - Low water storage capacity
  - No space to grow healthy roots
  - Pavement/Compaction:
    - Water does not reach the roots
    - No air
    - Heat stress



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URBAN MAPLE CONDITION IN NEW HAVEN:

- ***How sweet*** is the life of an urban maple in Connecticut?
- Measure and evaluate urban maple tree condition: tree size, damages, stress
- Measure site factors: Soil, root growth space, UHI
- **Does unpaved root growth space affect tree condition?**
- **Non-structural carbohydrates as a stress indicator (threshold values)**

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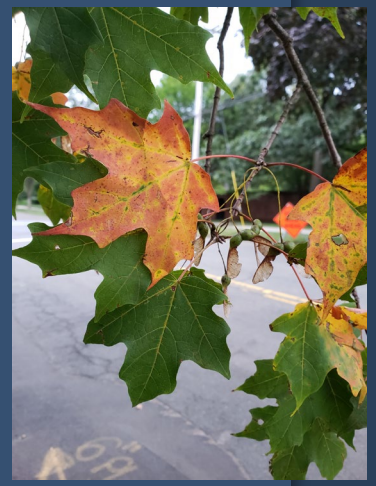
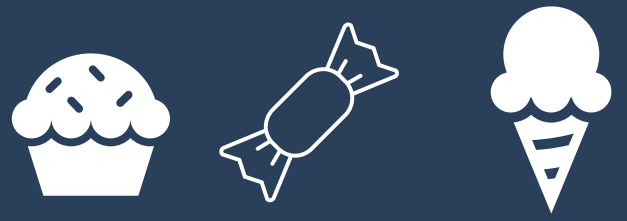


NON-STRUCTURAL CARBOHYDRATES AND TREE STRESS

STRESSED ←→ DESSERTS



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- Trees store photosynthetic products as non-structural carbohydrates (NSC) in stems, branches and coarse roots
  - Starch, sugars, "Tree snacks"
- Critical for tree **stress recovery** (Hartmann and Trumbore 2016)
  - As if you would go for a 20-mile hike and don't bring any snacks
- Replenishment of NSC reserves can take two favorable years (Landhäusser and Lieffers 2012)
- Tree species and stress severity affect recovery rates: For instance Norway maple recovers remarkably well (Ramirez et al. 2018).
- Can be monitored around the year, most stable in dormant season
  → Diagnostic potential? How many snacks the tree has left?

URBAN MAPLE CONDITION IN NEW HAVEN

- Questions:
  - Do urban maples with larger root growth space grow better and have lower stress levels?
  - Is root growth space associated with root NSC levels?

- Objectives:
  - Study the association of site and tree growth metrics with NSC levels in urban maples (Norway, red, sugar).
  - Identify NSC threshold values for early detection of urban maple decline

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URBAN MAPLE CONDITION IN NEW HAVEN

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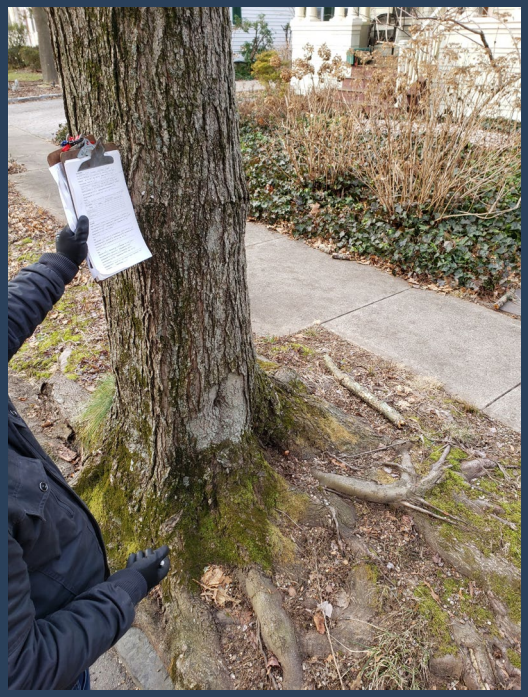
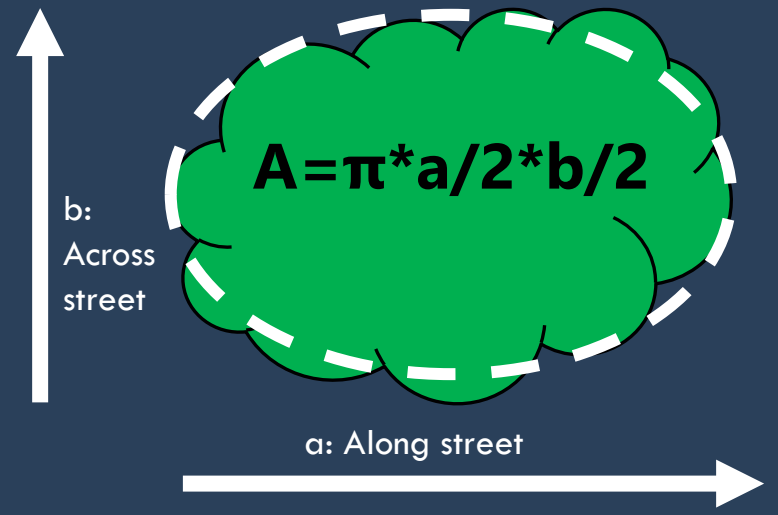
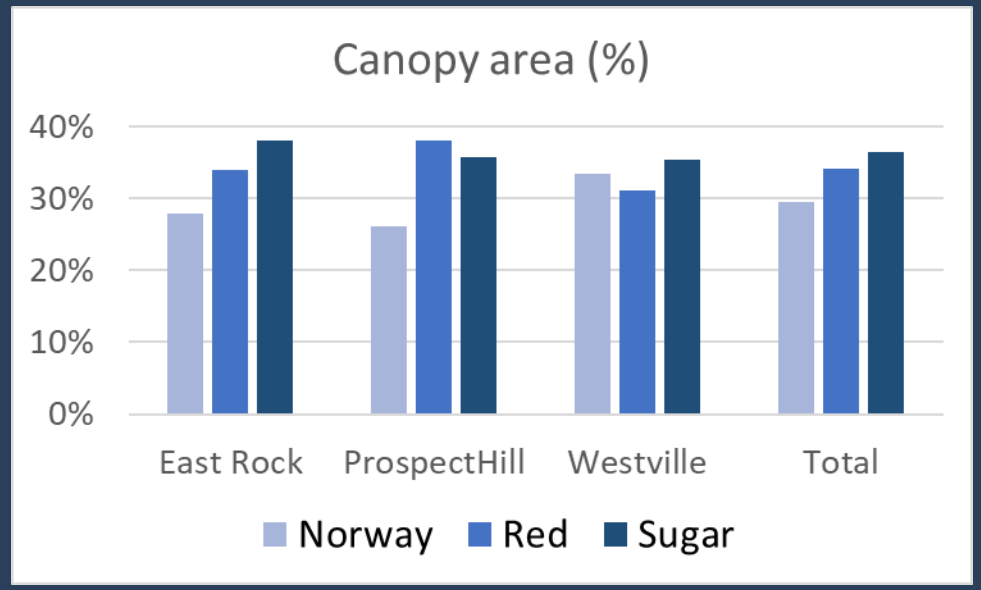
- Survey in January-February 2023
- 118 maples (dbh 36-67 cm), street trees
  - 39 Norway, 41 red, and 38 sugar maples
  - East Rock, Prospect Hill, Westville
    - High urban tree cover, easier to find trees
  - DBH, Height, Living crown height, canopy size, branch mortality, root damages, stem damages, shading
  - Size of unpaved root growth space was measured, and the paved area under the dripline was calculated.



URBAN MAPLE CONDITION IN NEW HAVEN

- **Canopy surface area** affects how much shade urban trees provide
- Total canopy area for 118 maples was 11,700 m^2 – about 2 football fields
- Sugar maple covered 36% of the total canopy area
- Norway maple
  - Prospect Hill: 25%
  - Westville: 33%





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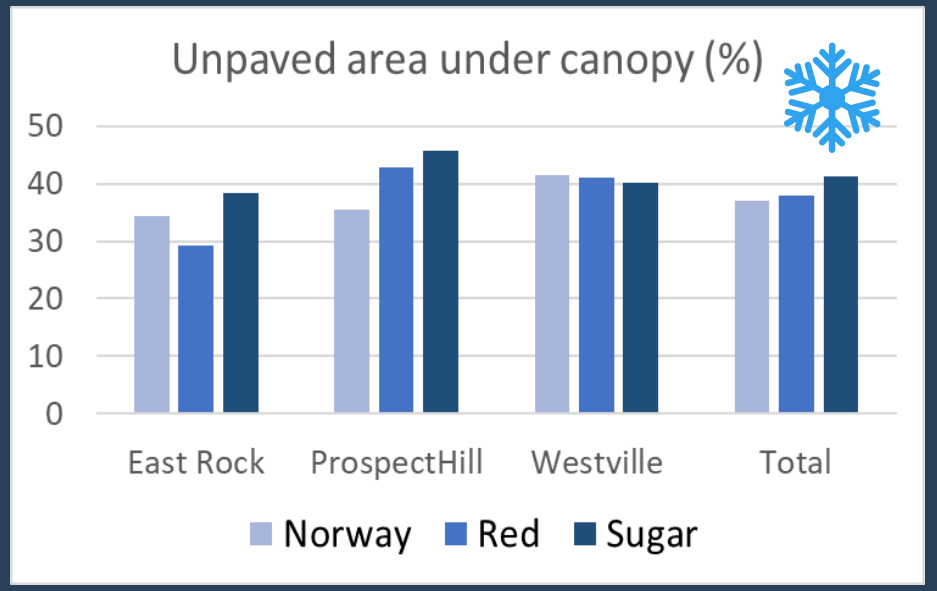
URBAN MAPLE CONDITION IN NEW HAVEN

- **Unpaved surface under the canopy** can affect the level of heat stress that trees must endure
- In total 4,812 m^2 unpaved – less than one football field
- Sugar maples had the largest unpaved canopy area (41%)
- Red maples in East Rock had only 29% of canopies unpaved
  - Unsung heroes: offer shade where it is most needed



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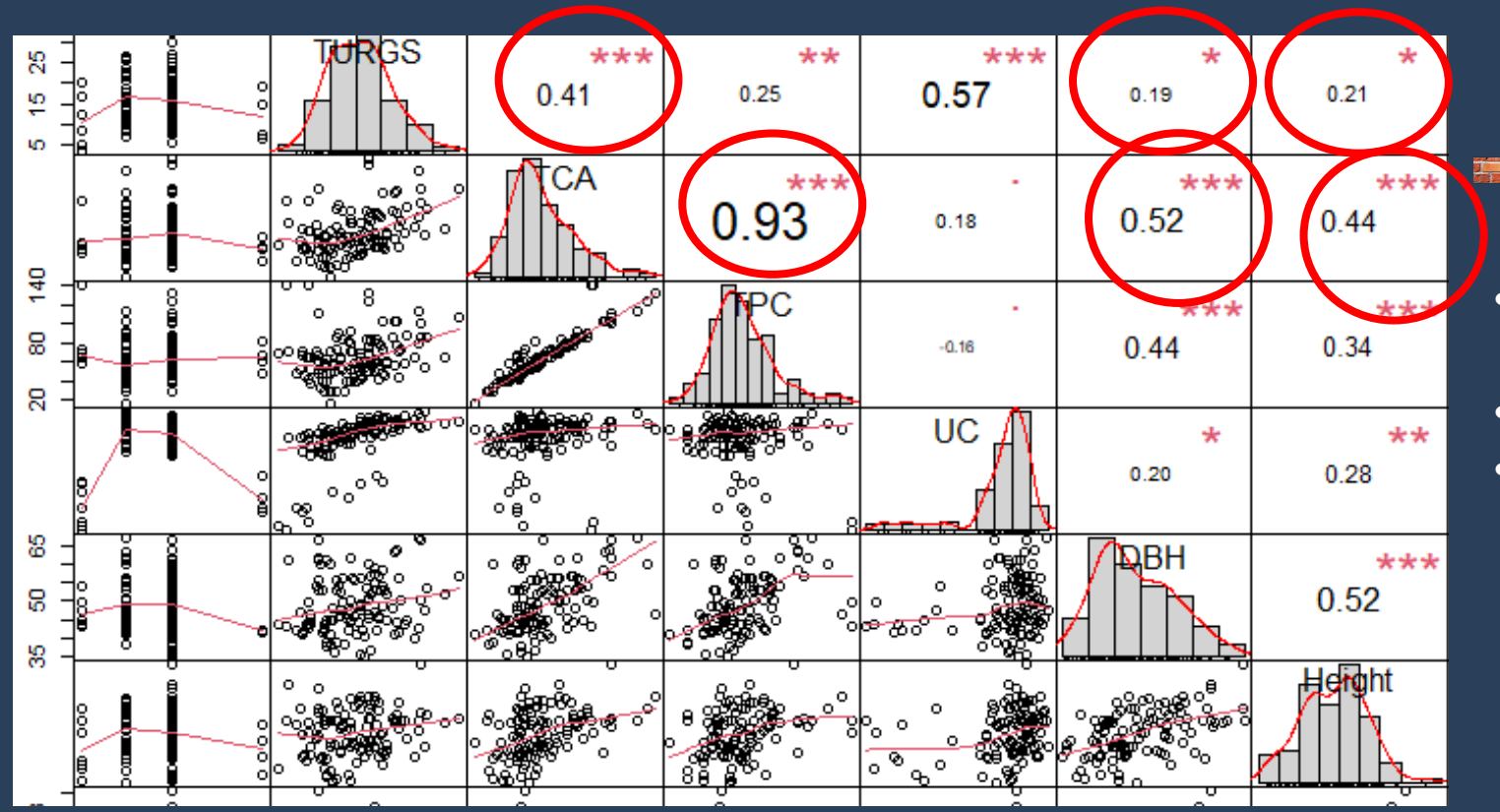
URBAN MAPLE CONDITION IN NEW HAVEN

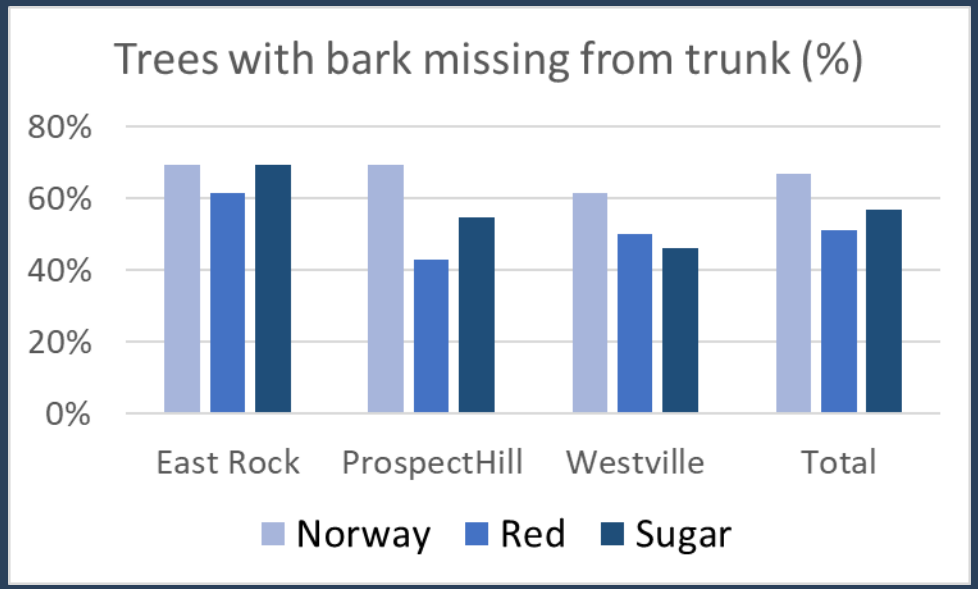
- Size matters for shading – larger trees have larger canopies
  - However, also paved canopy area increases
- Unpaved root growth space correlated with tree size
  - Not surprising



- TURGS=unpaved root growth space
- CA=canopy area
- TPC=paved canopy

URBAN MAPLE CONDITION IN NEW HAVEN

- **Bark damages on stem:** 58% of trees
- East Rock damage rate: 67%
  Westville damage rate: 53%
- Norway maple: 67% damaged



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URBAN MAPLE CONDITION IN NEW HAVEN

- **Root damages:** 88% of trees
  - Red maples: 100% had root damages
- **Girdling roots:** 73% of trees
- **Root collar buried** for 36% of Norway maples
- **Pavement dislocation:** Red maples

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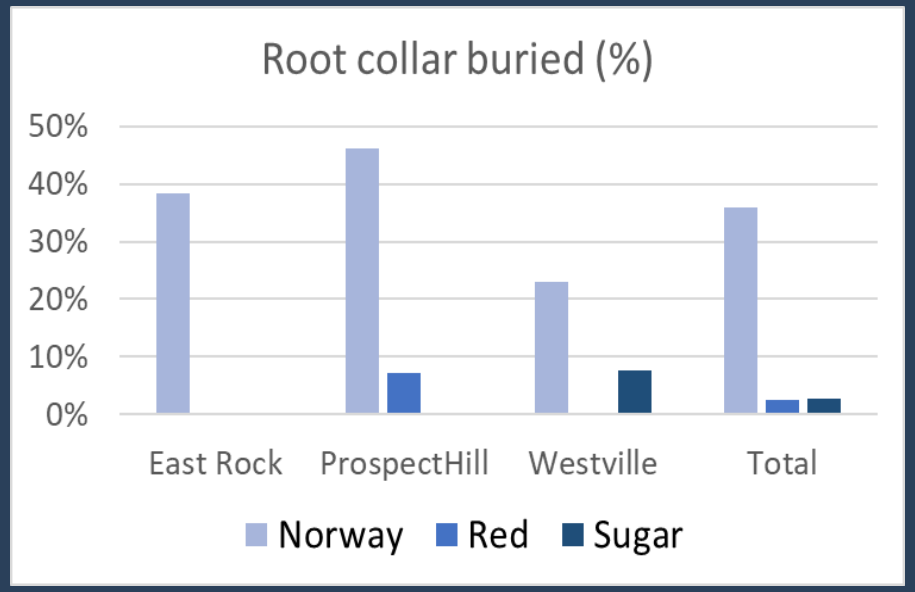

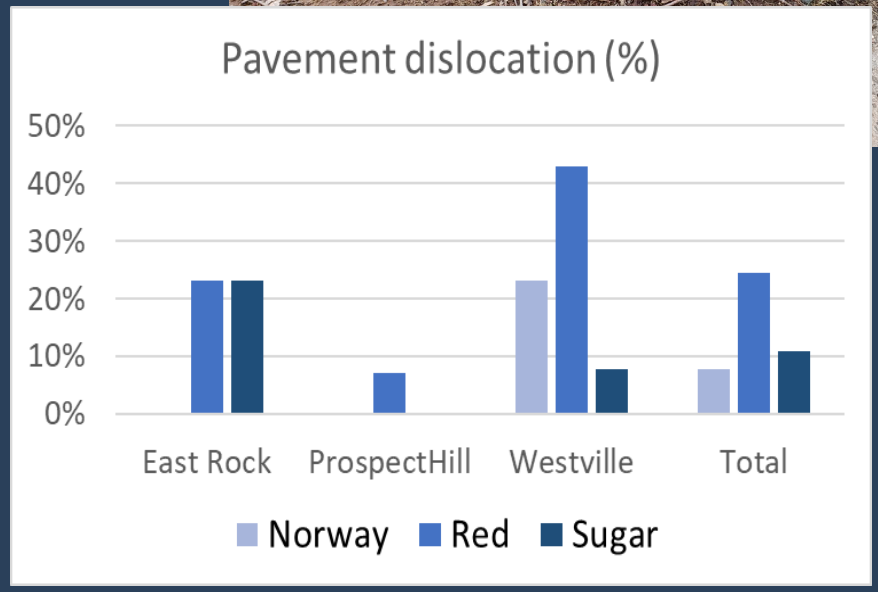

URBAN MAPLE CONDITION IN NEW HAVEN

- **Biotic damages:** not much – but we did not survey every tree, it was winter, and our trees are perhaps still relatively vigorous

Fruiting bodies on trunk: 4%

Biscogniauxia: 1 sugar

Sooty mold: 41% sugars

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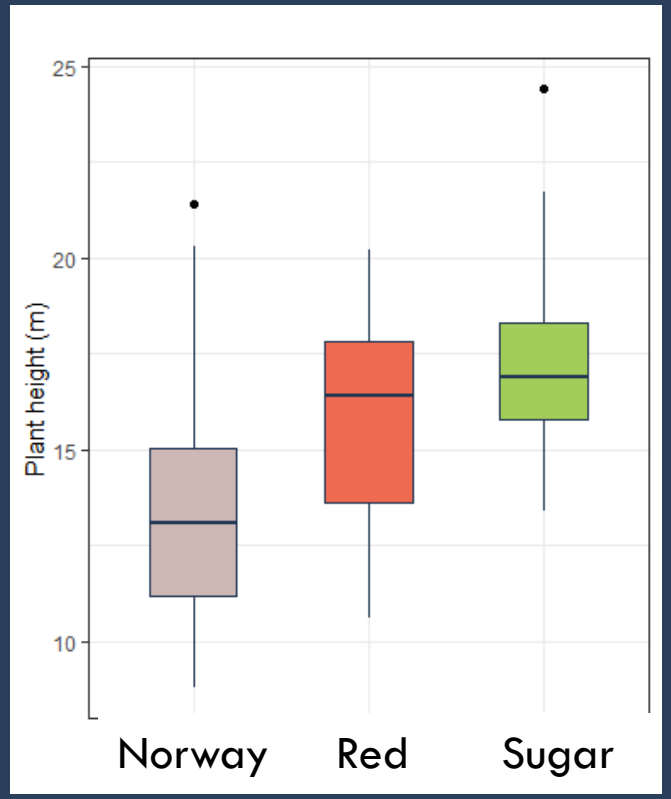
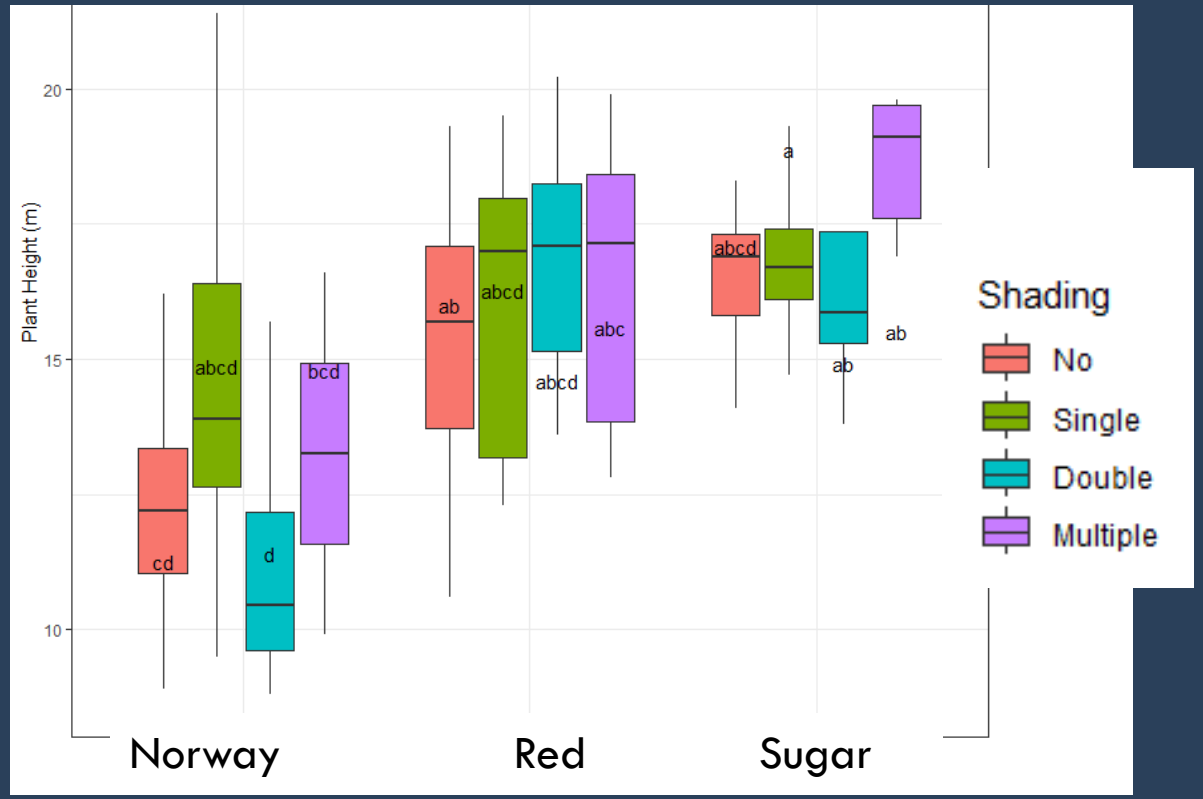
URBAN MAPLE CONDITION IN NEW HAVEN

- Tree height: Norway maples shortest: 13.3 m
- Sugar maples tallest: 17.1 m
- Some shading might be beneficial





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URBAN MAPLE CONDITION IN NEW HAVEN

- On average trees with no shade were shorter and had smaller diameters
- Benefits of shading for tree growth may relate to urban heat island effects
- Surface temp. East Rock: 76-79F; Prospect Hill 75-79F, Westville 74-78F
  - Westville trees were largest and had the largest canopies

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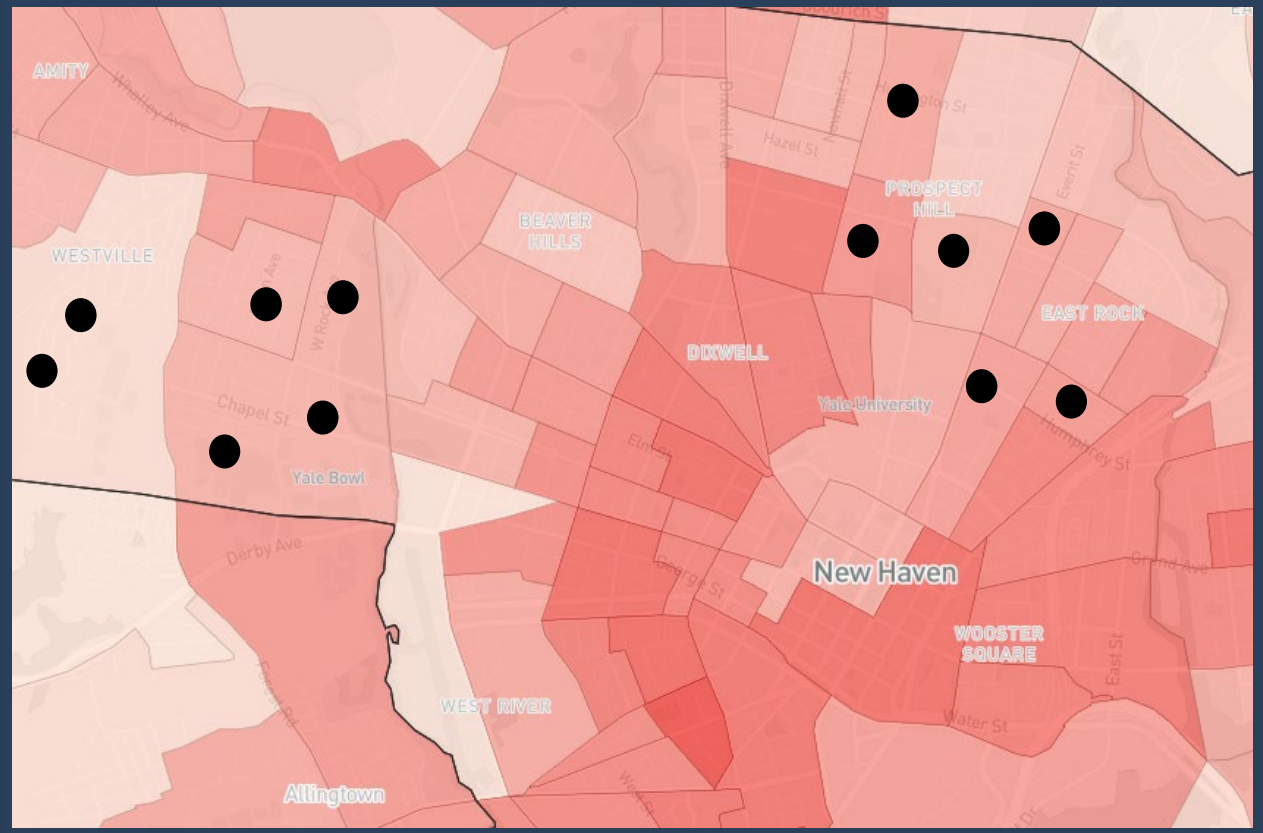
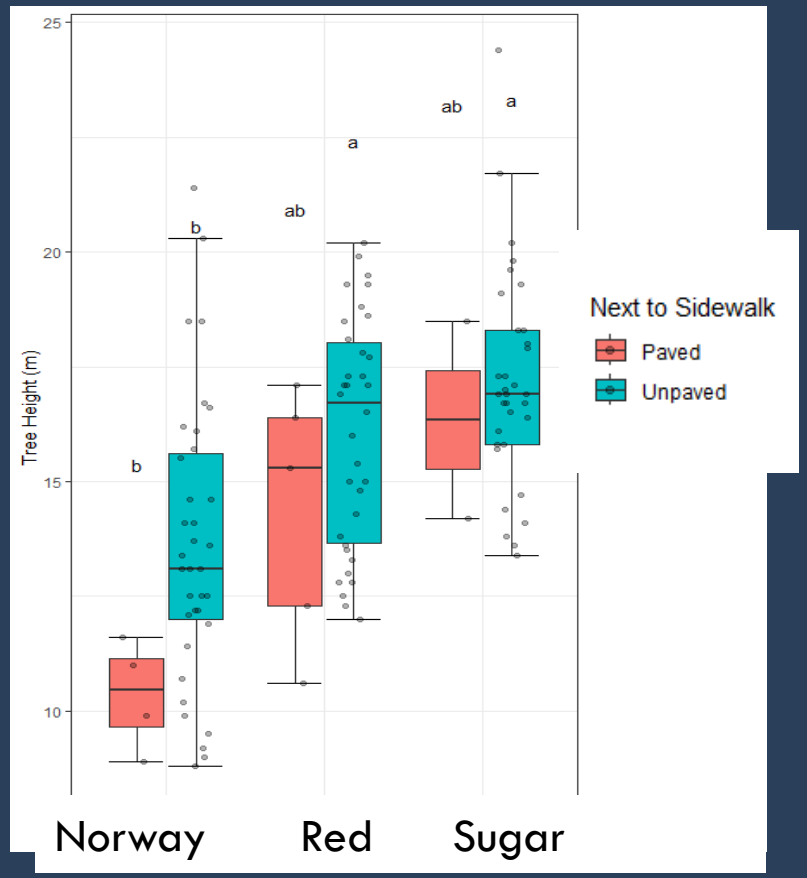


URBAN MAPLE CONDITION IN NEW HAVEN

- Tree height: If area next to sidewalk was paved, trees were shorter
  - Heat stress? Not necessarily power line conflicts
  - Norway maples (4 trees) in fully paved locations were shortest



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URBAN MAPLE CONDITION IN NEW HAVEN

- Powerline conflict: 72% of trees
  - Norway maple: 92% in East Rock but only 60% in Westville

    Sugar maple: 92% in Westville

    Red maple: 59% on average
- Does not necessarily impact height or crown area

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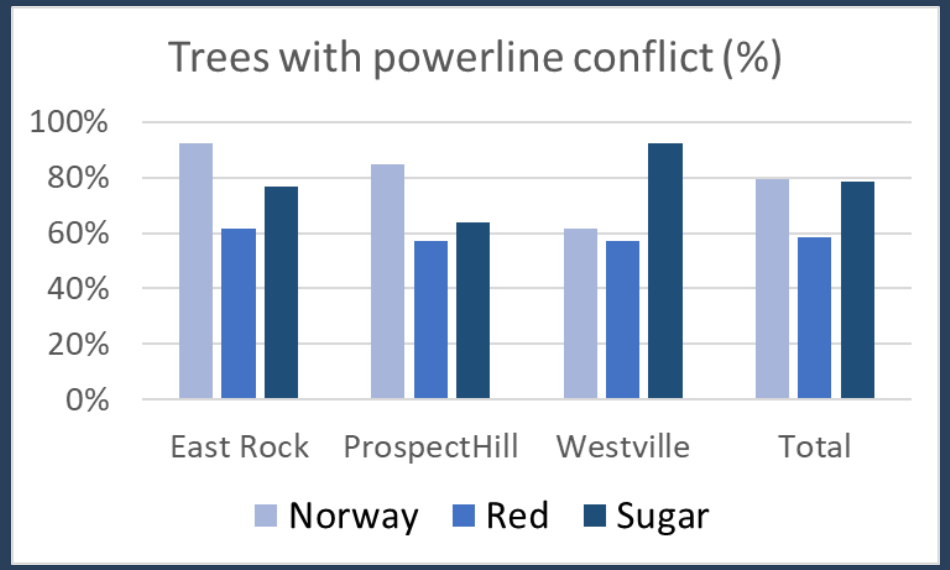

URBAN MAPLE CONDITION IN NEW HAVEN

- On average one urban maple provides 100 m2 of shade (1076 sq ft)
- Sugar maples provided most of the shading (Large trees → More shade)
- No such a thing as a perfect urban tree: damages either in stems (60%) or roots (88%) very common
- Worth looking into the factors that impact tree condition in different neighborhoods (UHI)

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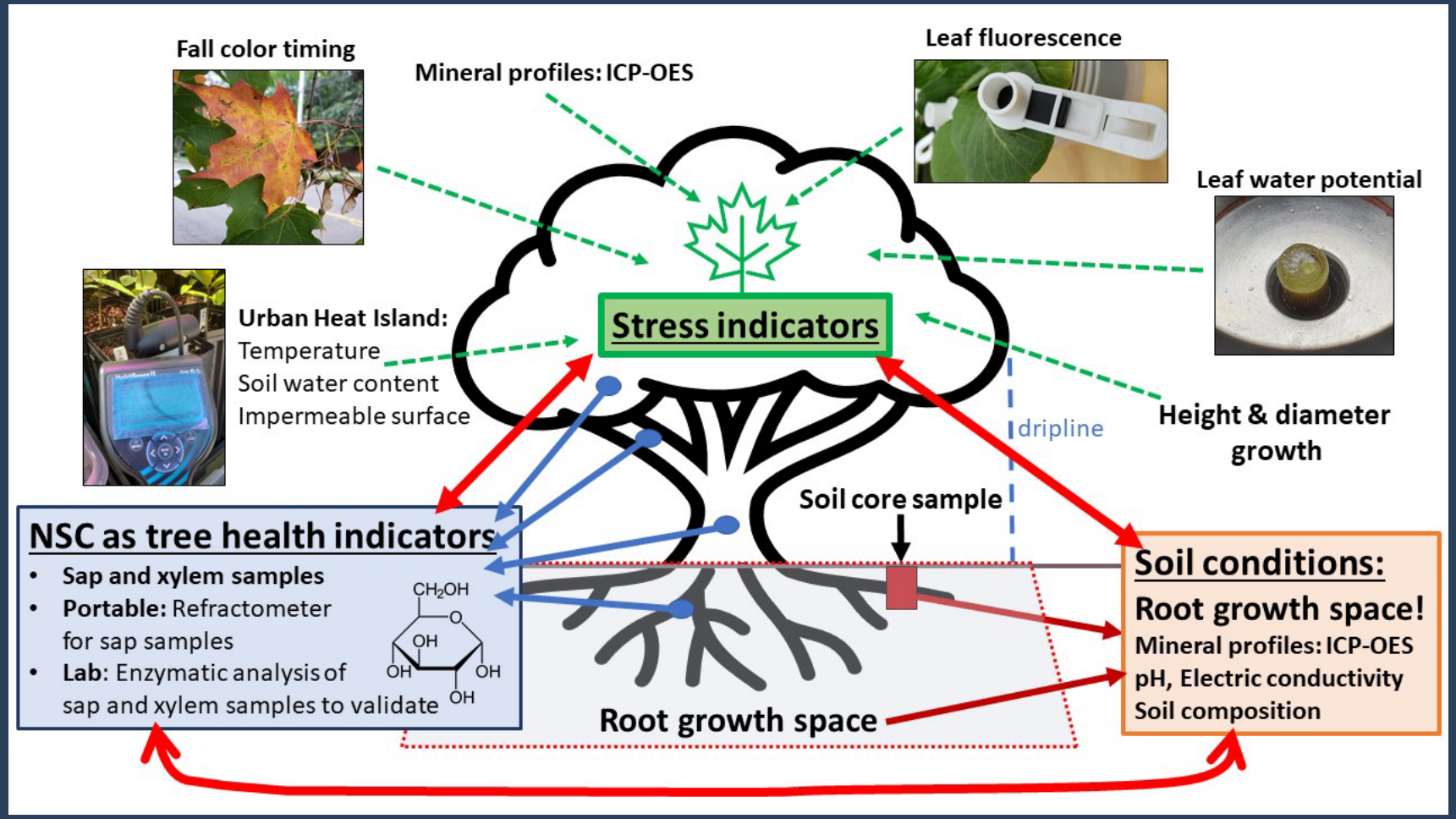
NEXT STEPS: OTHER STRESS METRICS

Measure tree growth metrics, UHI, collect soil data, physiological indicators, NSC levels



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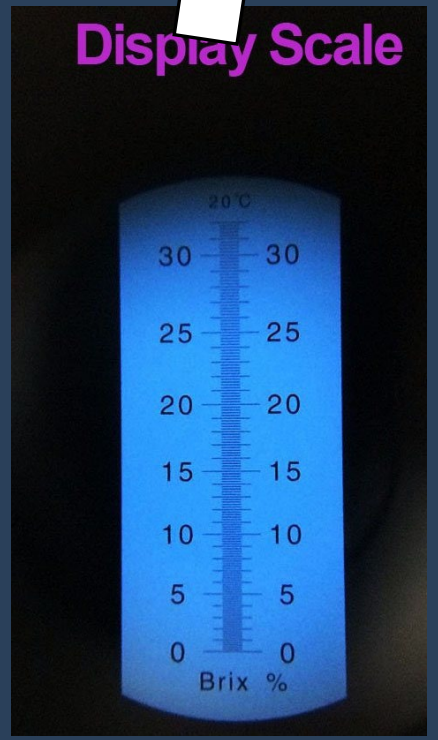
NEXT STEPS: NON-STRUCTURAL CARBOHYDRATES

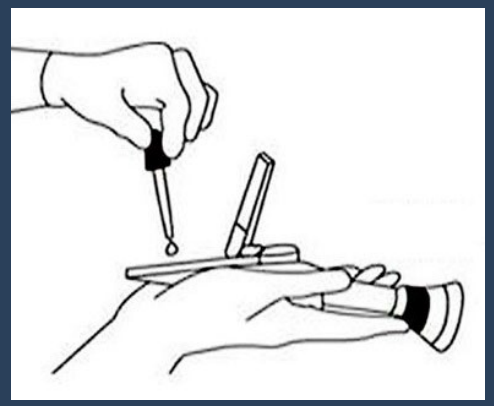
- Measure non-structural carbohydrate levels and identify threshold values for stress
- Study the association of site factors and UHI with carbohydrate levels
- Sap samples of high interest

Which value indicates stress?

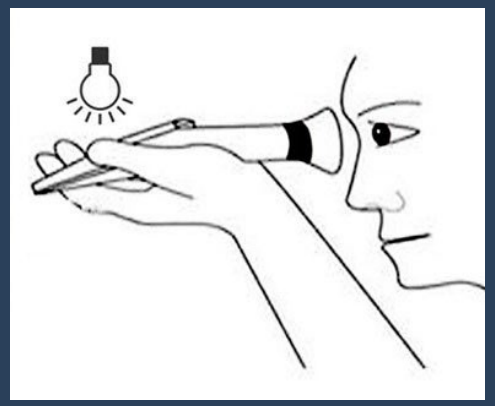


1. Collect sap.

2. Pipet sample.



3. Take the reading.



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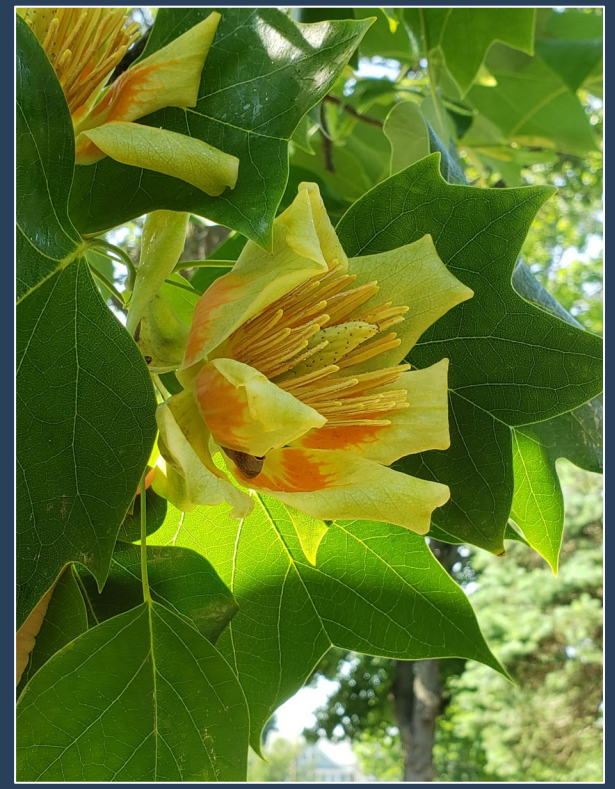
TAKE-HOME

- We need trees where the people are
  - Improve the resilience of cities
  - Improve access to green space
- Proper tree planting practices
- New approaches for maintaining a healthy urban tree canopy needed



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Questions?

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Protecting Agriculture, Public Health, and the Environment