A Novel Research Framework to Assess Water Quality Impacts of Urban Trees

Question B7, Water Quality of an Urban Tree

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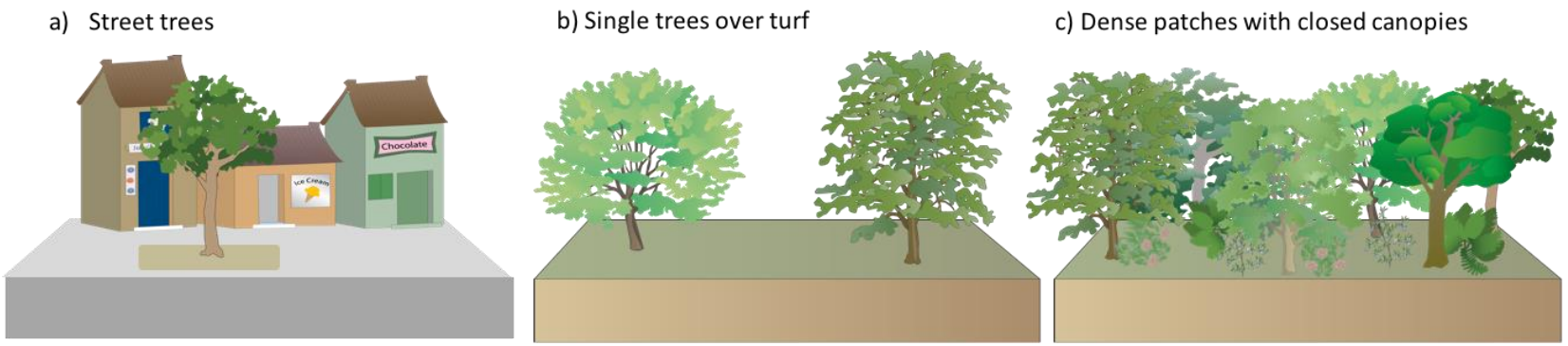
Research Questions to Evaluate the Effect of the Urban Forest on Water Quality and Quantity

1. Do urban forest characteristics that influence ecohydrology occur in common configurations and can these configurations be captured through the development of an urban forest typology?
2. Will more complex urban forest types (e.g., those having more canopy layers, greater density, more understory plants or shrubs, litter layers, etc.) reduce runoff volume to a greater extent than simpler configurations?
3. How do different tree species affect runoff response?

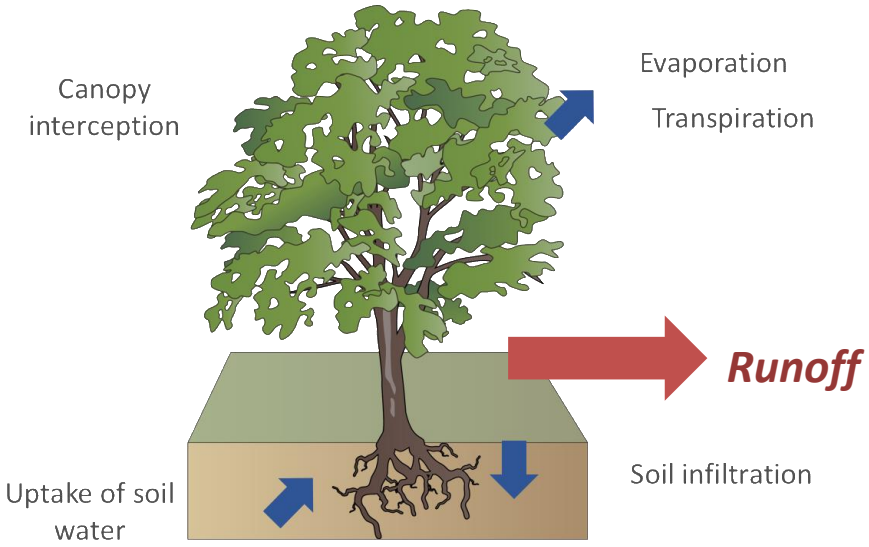


Examples of different urban tree typologies. (Images courtesy of the Integration and Application Network, UMD Center for Environmental Science)

STUDY APPROACH

- **Identify** urban forest typologies to effectively characterize and **quantify runoff reduction** and water quality benefits of urban tree canopy for stormwater management
- **Water balance monitoring & modeling** of selected urban forest typology types will inform stormwater benefits along a continuum of typologies
- Compare with existing urban tree canopy runoff and pollutant reduction **credits**

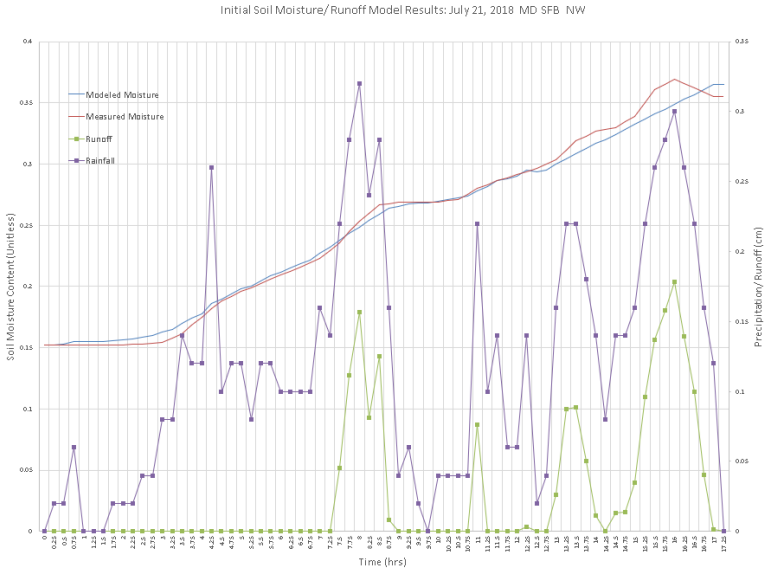
URBAN TREE WATER BALANCE



Mass Balance Approach: Runoff Reduction

Input = Output – ΔStorage

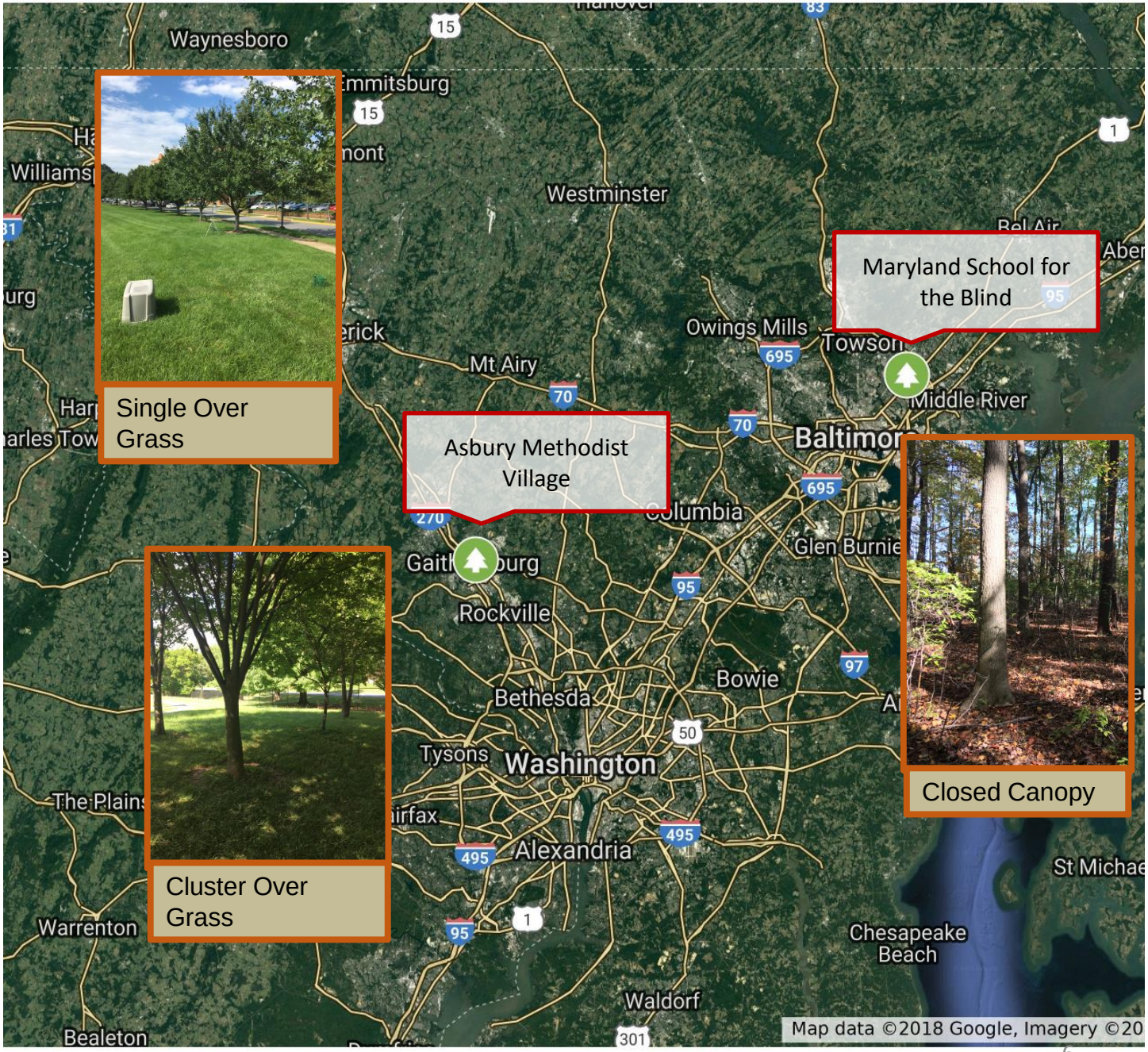
Runoff *when storage exceeds capacity*



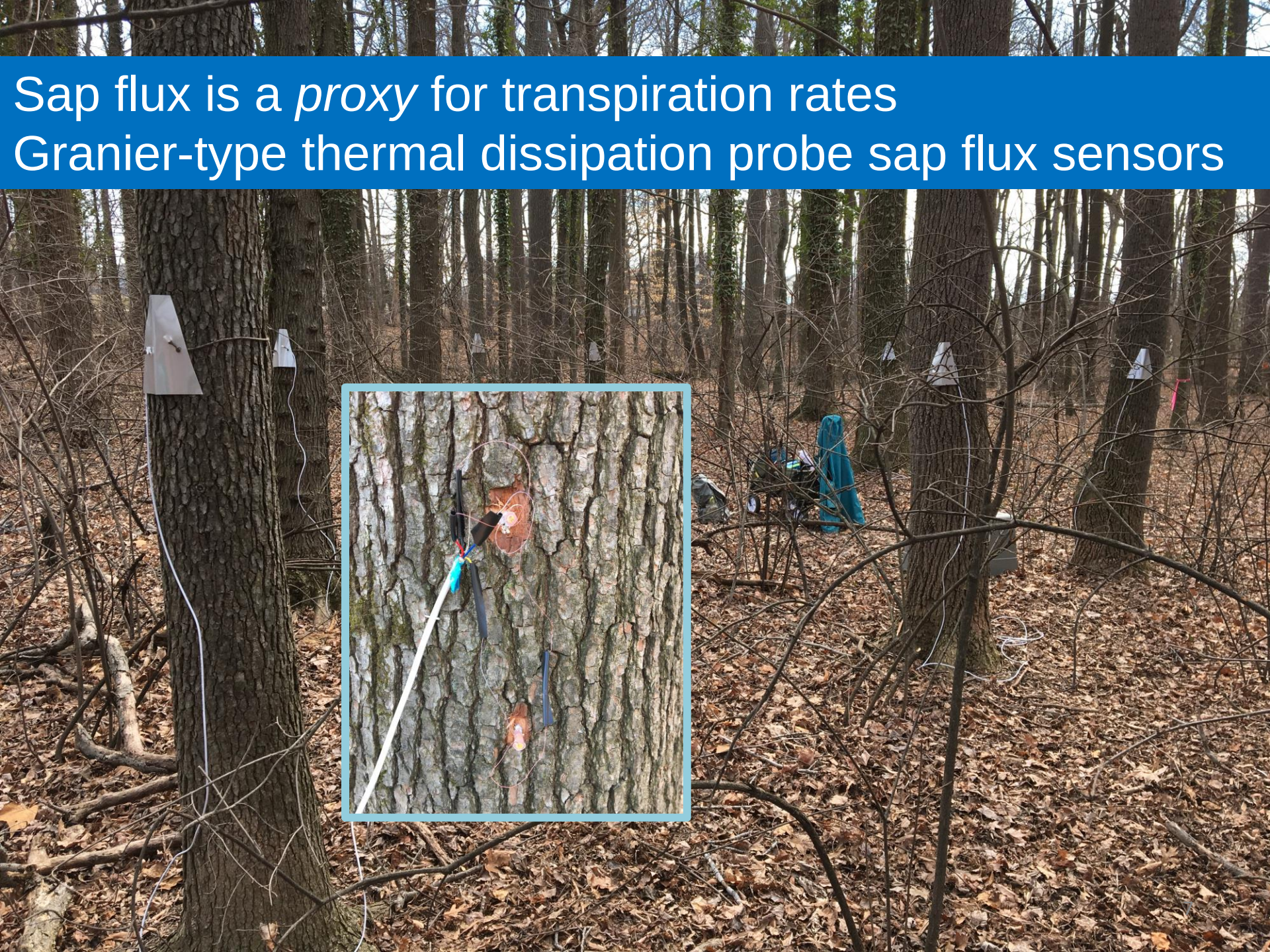
Study Area

Criteria:

- Site accessibility
- Safety for the research equipment
- Recommended by the Montgomery County

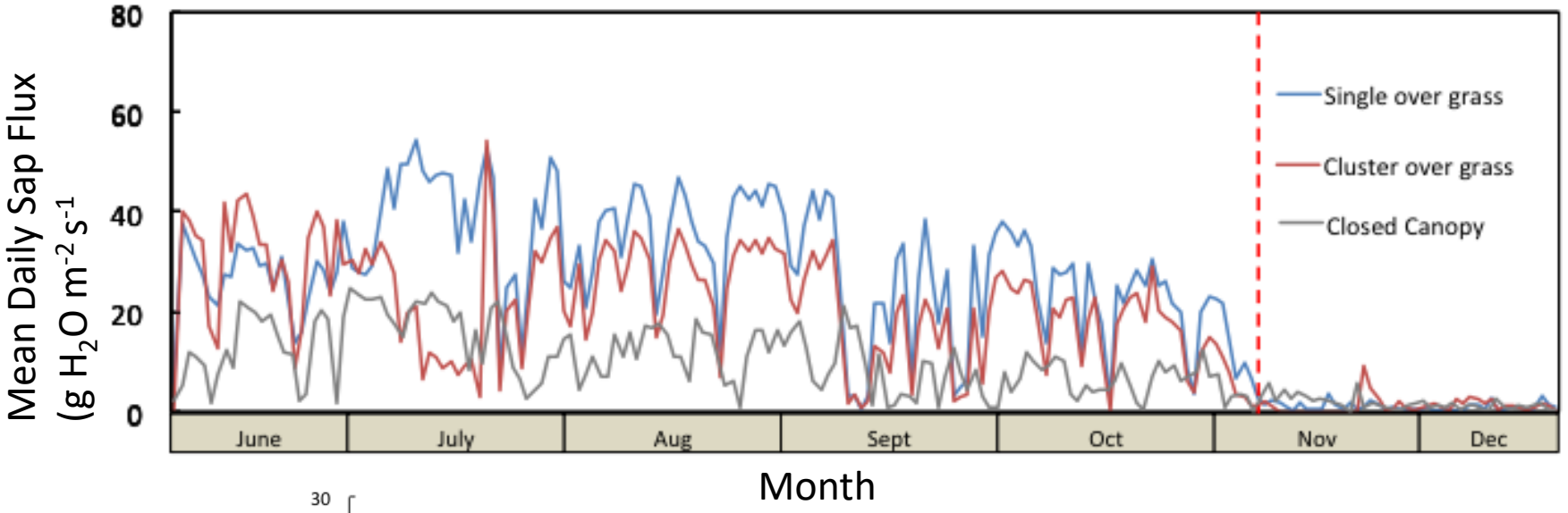


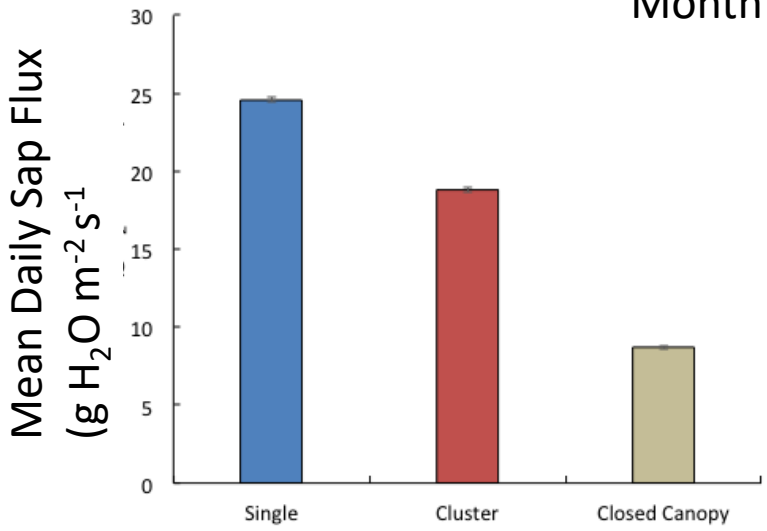
Sap flux is a *proxy* for transpiration rates
Granier-type thermal dissipation probe sap flux sensors



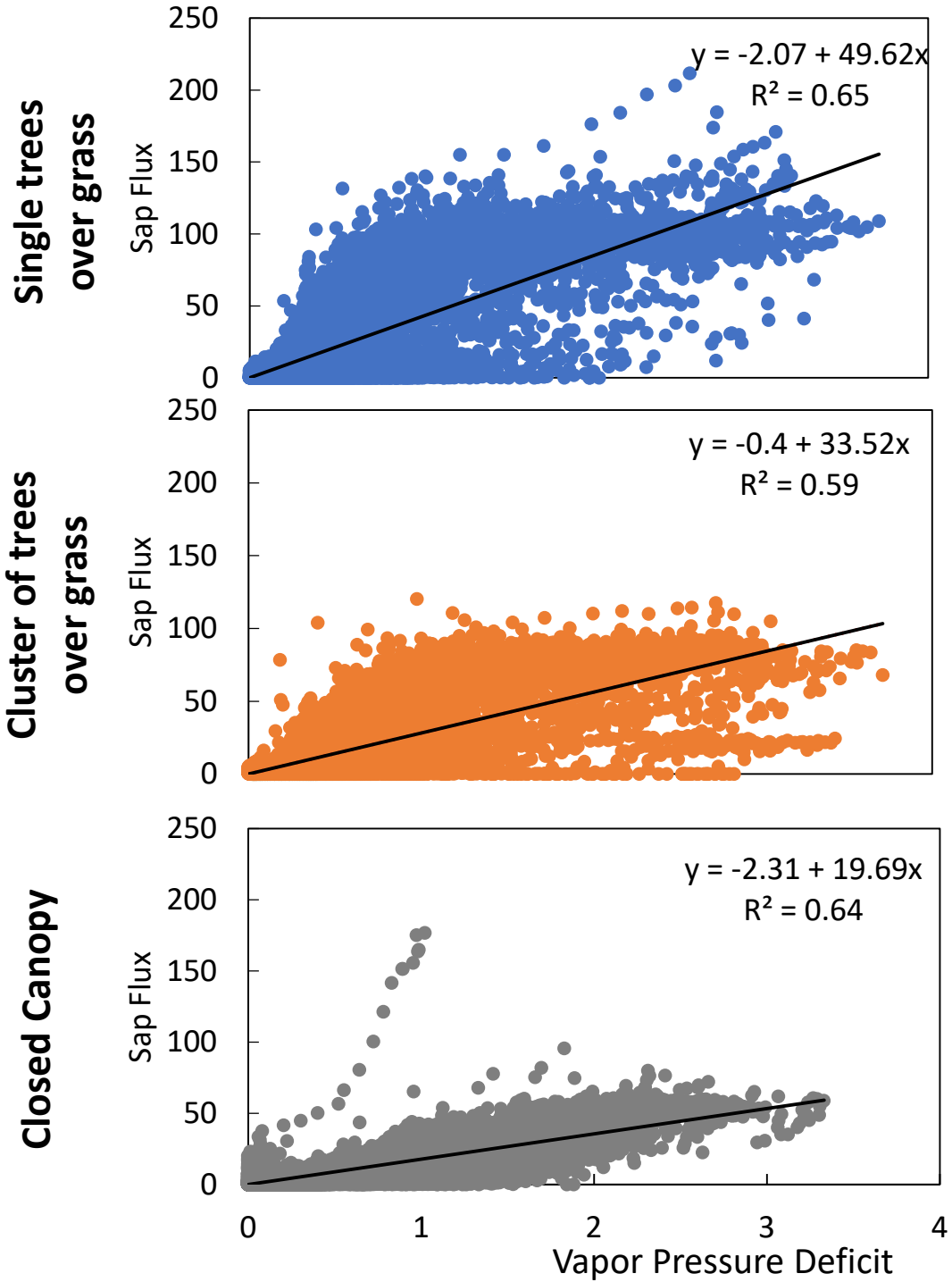
Weather Station: temperature, precipitation, humidity
Soil moisture sensors
Canopy interception (rain gauge)

Mean daily sap flux for single trees was greater than cluster and closed canopy trees





When averaged over the entire measurement period:
single trees have twice the sap flux of closed canopy trees



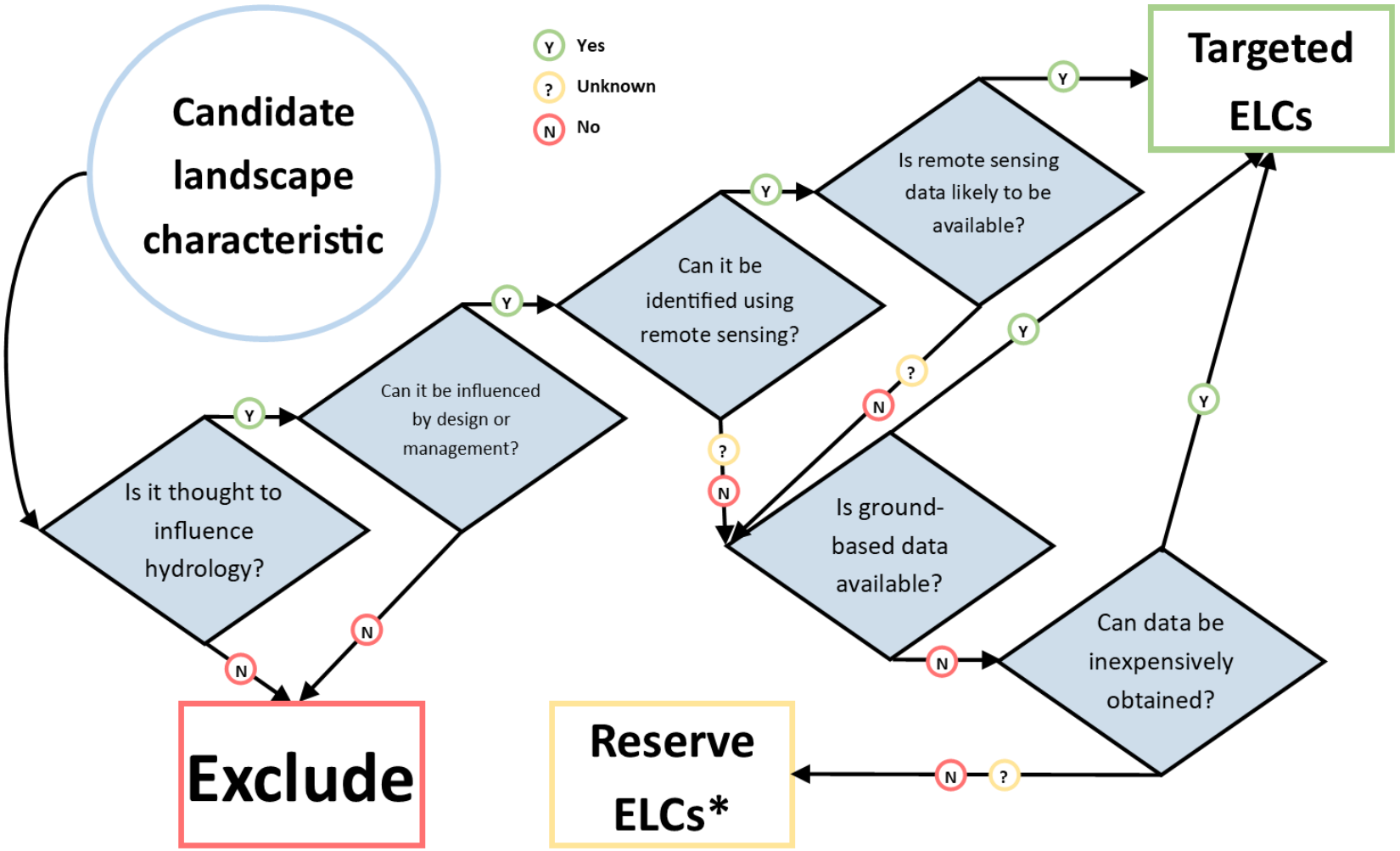
- Trees at the single tree site are more responsive to environmental drivers
- Implies an interaction between context, site management (species, cover, density, etc), and transpiration

URBAN FOREST TYPOLOGY

Developing a typology is iterative

Identify **Ecohydrological Landscape Characteristics** (ELCs)

ELCs are variables that relate to ecohydrological impact and can be influenced through management or design. We developed a decision tree to determine whether or not an urban forest characteristic is considered an ELC.


Candidate landscape characteristic
Y Yes
? Unknown
N No
Is it thought to influence hydrology?
Y
N
Can it be influenced by design or management?
Y
N
Can it be identified using remote sensing?
Y
?
N
Is remote sensing data likely to be available?
Y
?
N
Is ground-based data available?
Y
N
Can data be inexpensively obtained?
Y
N
?
Targeted ELCs
Reserve ELCs*
Exclude

Developing a typology is iterative

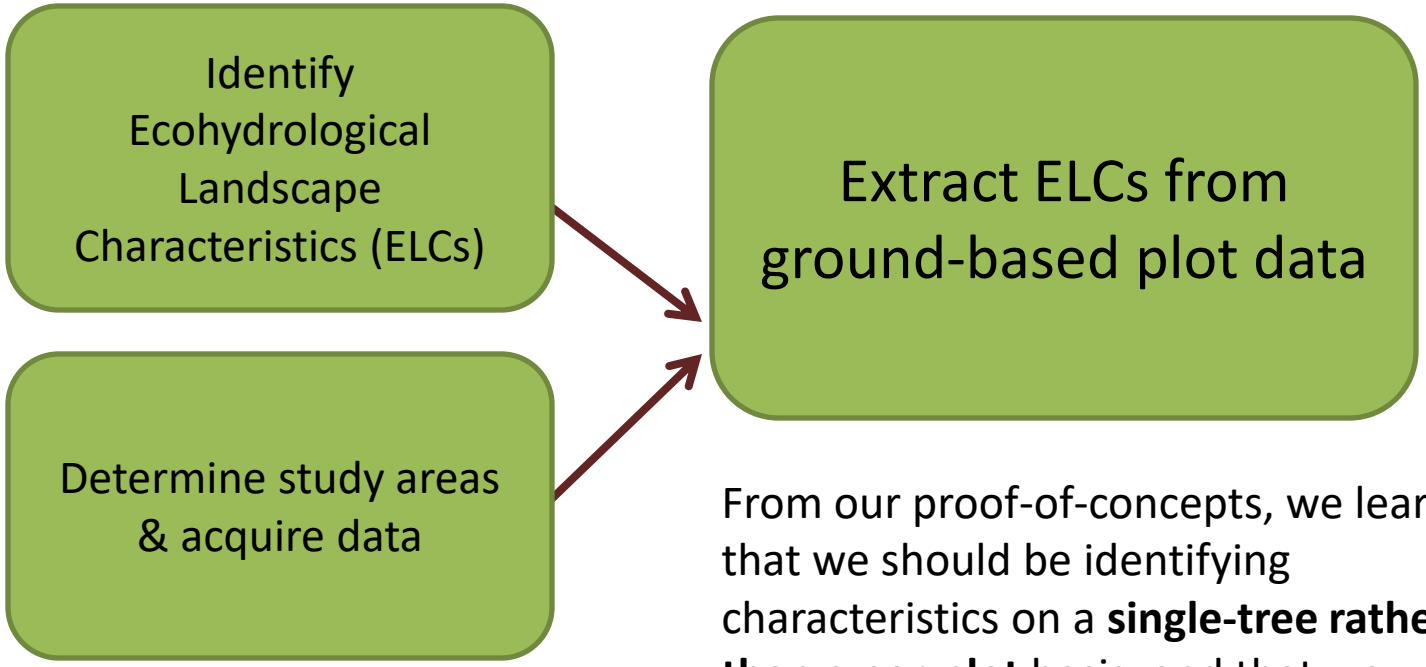
Identify Ecohydrological Landscape Characteristics (ELCs)

ELCs are variables that relate to ecohydrological impact and can be influenced through management or design (e.g., tree species, ground cover type, canopy density, etc.). We developed a decision tree to determine whether or not an urban forest characteristic is considered an ELC.

Determine study areas & acquire data

Proof-of-concept has been tested in Austin, TX and Blacksburg, VA. Further testing is being completed for Baltimore, MD. We have compiled ground-based urban forest data (i-Tree Eco and Urban FIA), along with remote sensing data (Lidar and aerial imagery).

Developing a typology is iterative

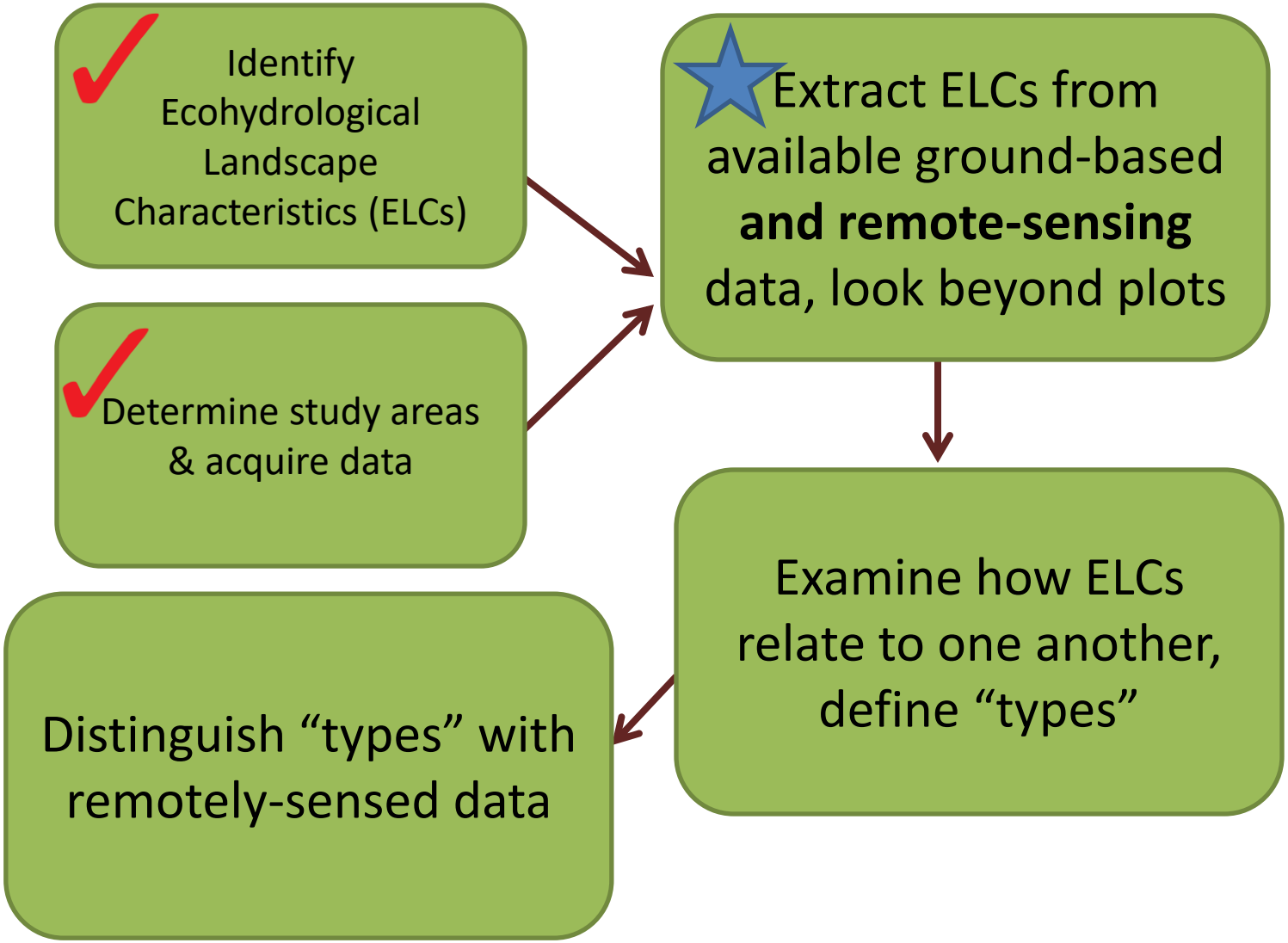


From our proof-of-concepts, we learned that we should be identifying characteristics on a **single-tree rather than a per-plot** basis, and that we should use both **remote-sensing and ground-based data** to extract ELCs. We saw that ground-based plot characteristics alone do not provide enough context about the environment an urban tree exists in.

Urban forests are so varied--trees with very different growing conditions can be close!

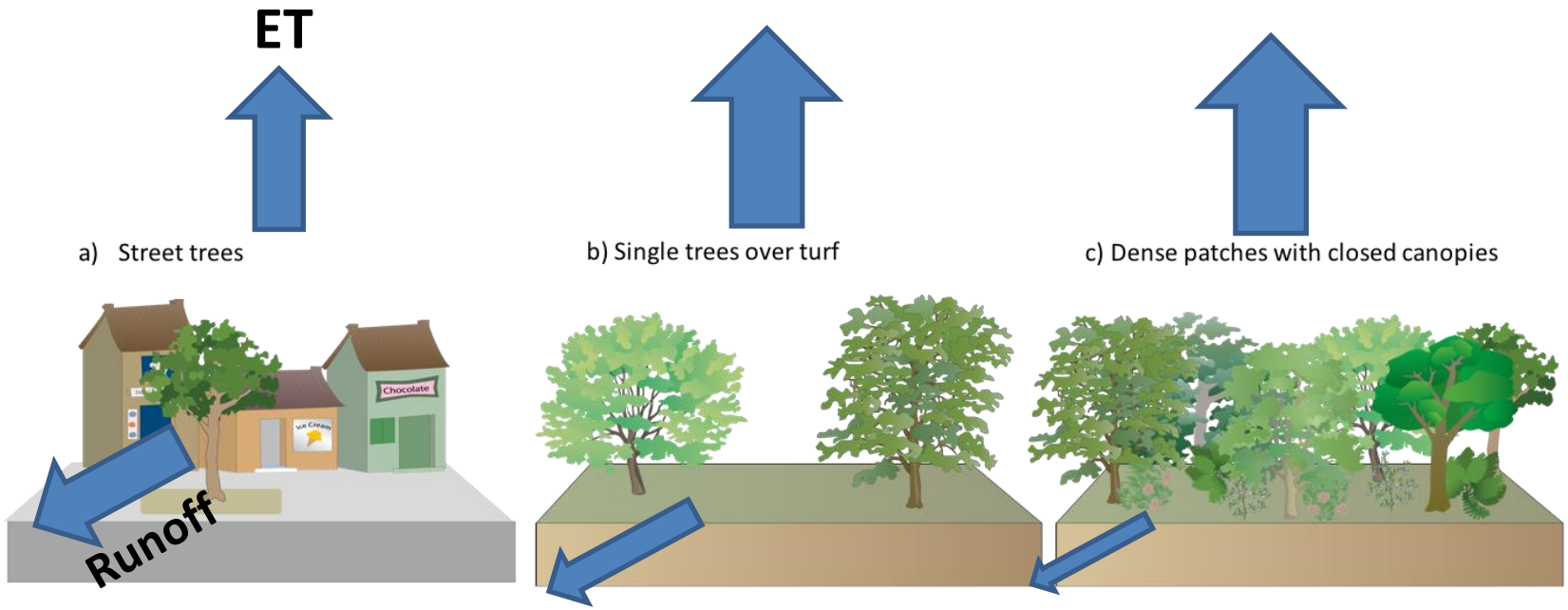
Image Credit: Jeffrey Milstein

How are we developing our typology?



Data Integration & Synthesis

- Monitoring data provides runoff reduction for 3 urban forest typologies
  - Closed canopy, small cluster and single tree
- Place 3 typologies as part of all possible urban tree canopy continuum
- Identify the type of typologies present in Montgomery County
- Compare results of monitoring to existing tree canopy stormwater credits.
  - e.g Relate to N, P and S reduction relevant to Chesapeake Bay



Examples of different urban tree typologies. (Images courtesy of the Integration and Application Network, UMD Center for Environmental Science)

Acknowledgment Slide

The Project team gratefully acknowledges funding provided by Montgomery County Department of Environmental Protection to support this work.

Translation Slides by Steve Shofar

What does this mean for me?

- Site-specific research relevant to Montgomery County existing tree canopy (directly applicable). Study design will allow for broader applications.
- This research will allow us to get closer to being able to get a stormwater credit for trees in Maryland
- There may be a time in the not too distance future where established trees could remain in place rather than be removed and a stormwater BMP constructed.

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What does this mean for me?

What do I take from this if I am a practitioner:

- Potential for a variable credit. Go beyond “one size fits all” credit for trees; adapt to existing tree canopy and/or development patters
- We are getting closer to being able to get stormwater credit for trees. There may be some instances where it makes sense to leave trees in place rather then remove them and put in a constructed stormwater BMP.

What do I take from this if I am a regulator:

- Potential for a variable credit. Go beyond “one size fits all” credit for trees; adapt to existing tree canopy and/or development patters
- Consideration should be given as to how this credit will be implemented from a regulatory perspective.