

TREE INVENTORY FOR URBAN FOREST MANAGEMENT

Kelsey Watkins

Technical Expert, Environmental Analytics | NV5

N|V|5

The Nature Conservancy

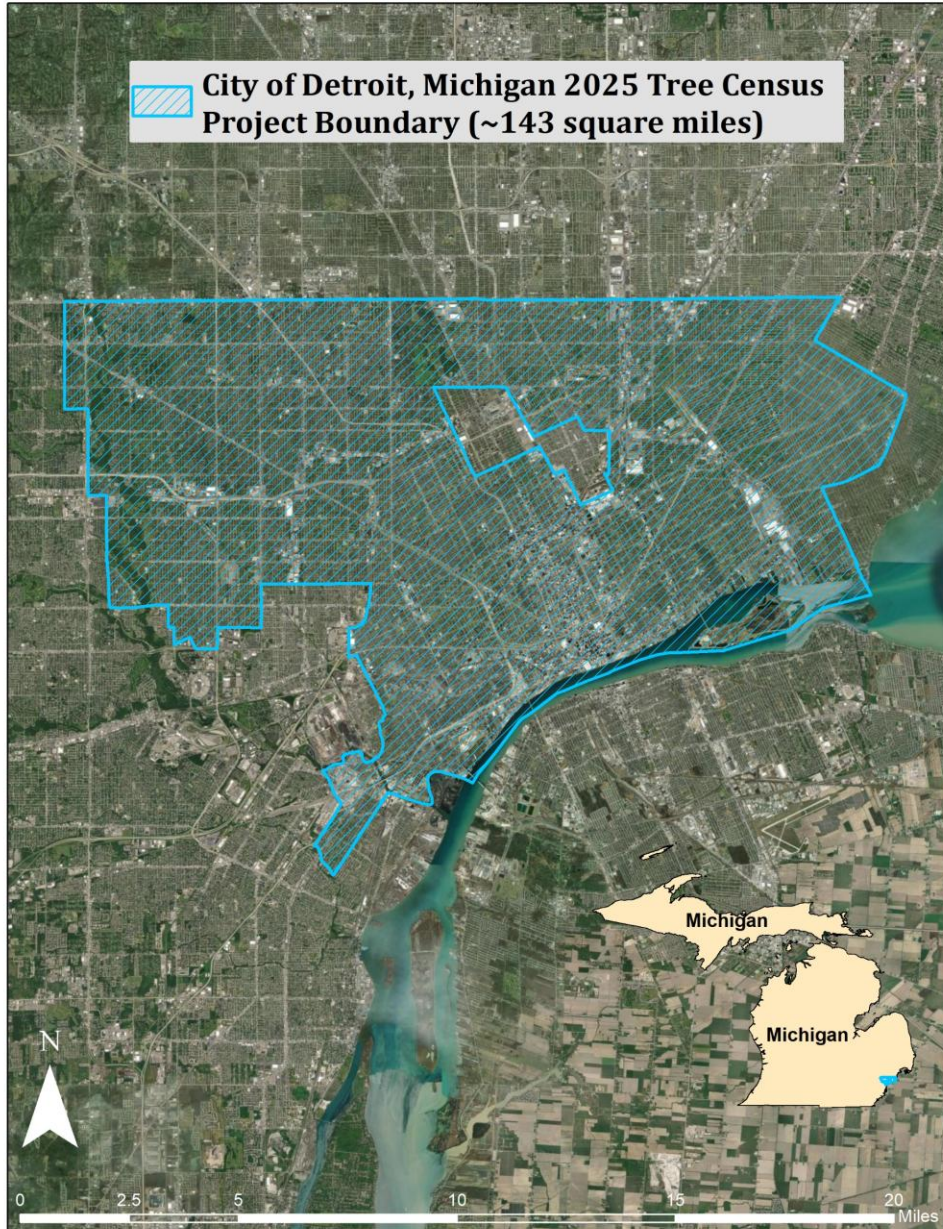




OVERVIEW

- Project Overview
- Technical Approach
- Demo of System
- Results and Decisions

PROJECT OVERVIEW



Project Area: City of Detroit, Michigan

- 143 square miles

Client: The Nature Conservancy (TNC)

Main Partners:

- The City of Detroit
- The Greening of Detroit

Project Objectives:

1. Create an updated database of all trees within the City of Detroit, classified by species and health (vigor).
2. Develop a GIS tool or interface designed to support Urban Forestry groups and engage the public and planting partners.

TECHNICAL APPROACH

NV5 utilized multiple data sources and conducted the project work in four phases:

Phase 1: Tree Segmentation

- Reprocess previous 2021 DTE Energy Lidar: 40 points/square meter
- Complete tree segmentation with lidar derived heights

Phase 2: Imagery Collection and Field Work

- Acquire and process RGBN 6" imagery in Summer of 2025
- Field data collection for model training

Phase 3: Refine and Classify Trees, Create Open Planting Databases

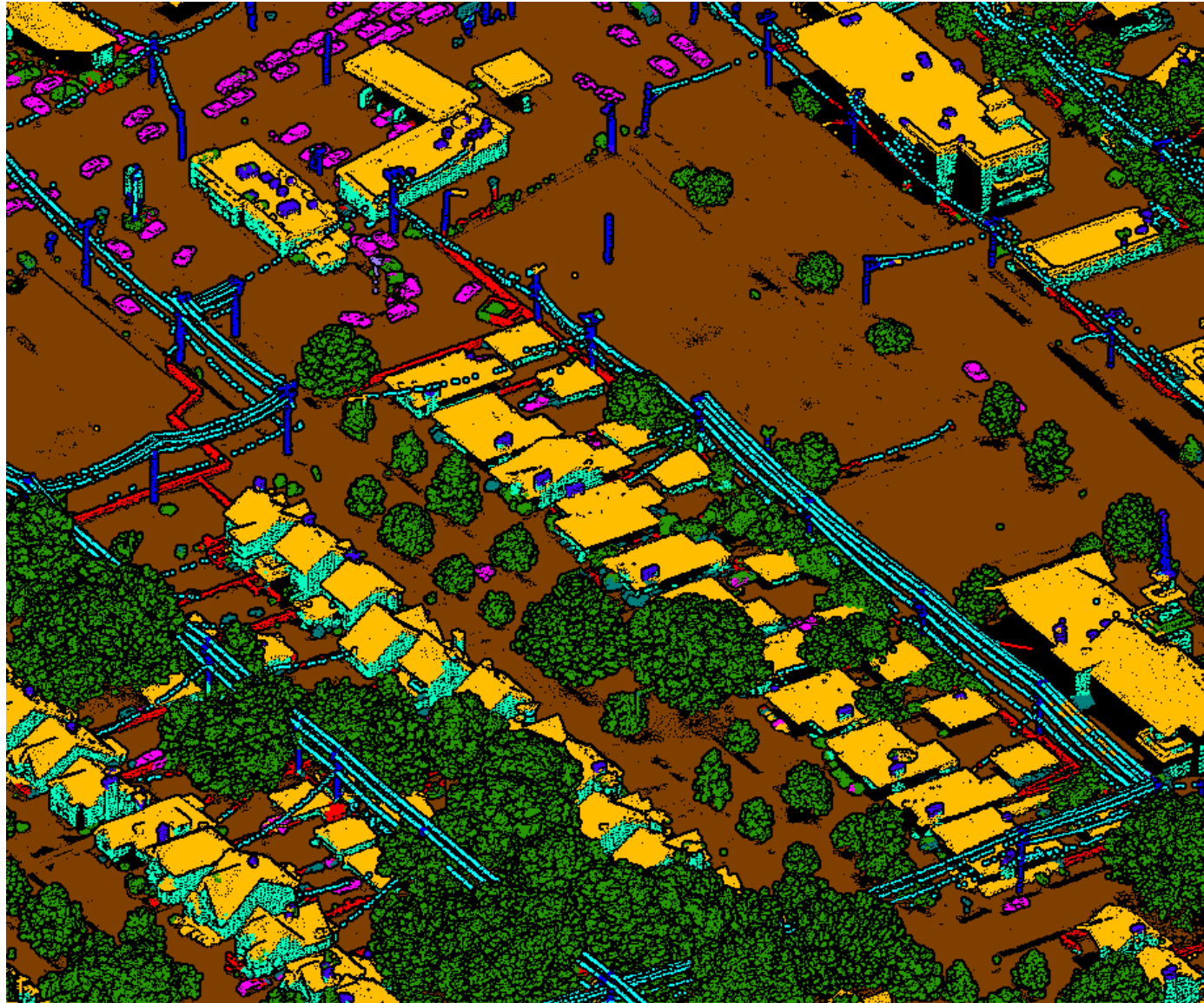
- Machine learning classification of tree species groups and health
- Identify open planting spaces classified by land cover type

Phase 4: Set up interactive site for Client Use

- Tree Viewer

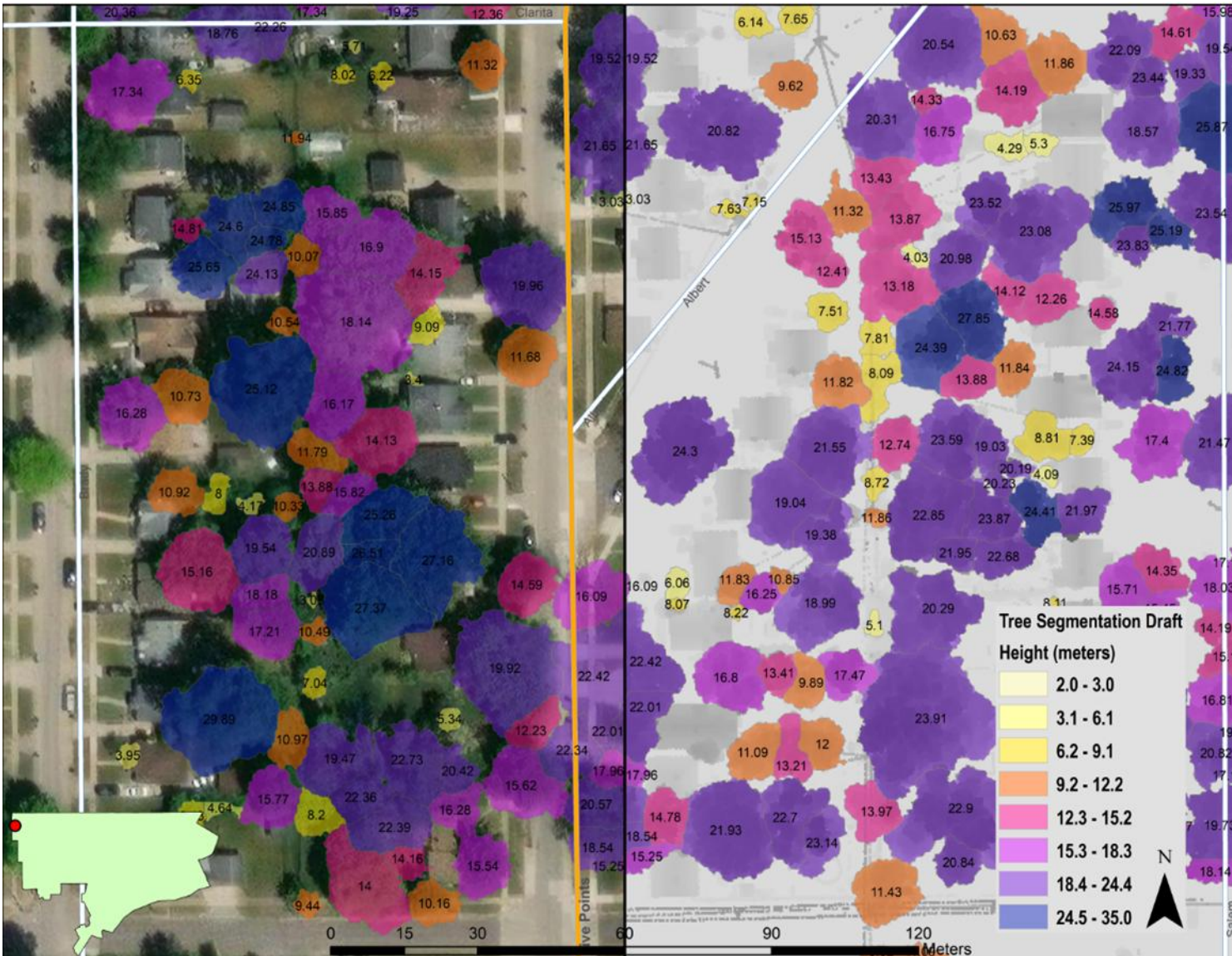
PHASE 1: LIDAR CLASSIFICATION

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Code	Description	Draw	Lvl	Color
1	Unassigned	Not set	1	
2	Ground	Not set	2	
5	High Vegetation	Not set	5	
6	Building	Not set	6	
7	Noise	Not set	7	
9	Water	Not set	8	
14	Wire	Not set	10	
15	Transmission Tower	Not set	15	
19	Overhead Structure	Not set	18	
80	Fence	Not set	80	
81	Vehicle	Not set	92	
86	Building Rooftop Object	Not set	92	
87	Building Wall	Not set	92	
90	Pole	Not set	90	
91	Pole (No Wires)	Not set	91	
129	Class 129	Not set	129	

PHASE 1: TREE SEGMENTATION



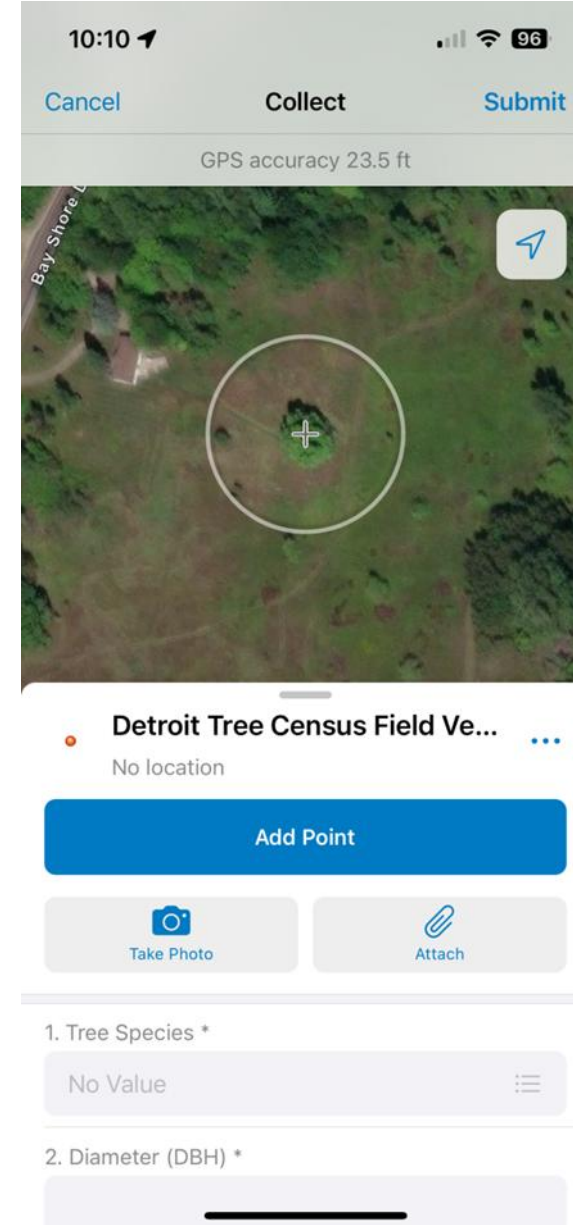
Segmentation

- Tree Number Unique ID
- Tree Height (derived from lidar nDSM)
- Tree Location
- Crown Area
- Low Lying Branches (presence of branches below 6')

Mapped trees 10 ft in height or greater, smaller as feasible

PHASE 2: CREATE A REFERENCE DATABASE

- Ingestion of Client Provided Tree Data
 - City of Detroit – Cartegraph Database
 - Other tree data that exists in spreadsheets and other formats
- Ground Truthing Field Work
 - Targeted 10 sites which were poorly mapped in existing records. Largely non-street trees, such as golf courses, parks, etc.
 - Tree Database accessible with Tree Segmentation and field data recorded using ArcGIS Field Maps Application
 - The Greening of Detroit, Student interns, and GSD staff



PHASE 2: IMAGERY PROCESSING AND POINT CLOUD COLORIZATION

- Acquire and process RGBN 6" imagery in Summer of 2025
- Ray Tracing to create a colored point cloud.
- 4-band images from the colored point cloud to 'stand up' tree lean and align structural and spectral tree information.



Left: Ray Traced Image, Right: Orthoimagery

PHASE 3: TREE ATTRIBUTION

Final Tree Segmentation, ESRI Geodatabase

Attributes:

- Tree Number Unique ID
- Tree Height
- Tree Location
- Crown Diameter Area
- Low Lying Branches (presence of branches below 6')
- *Diameter at Breast Height (DBH)
- *Genus/Species Common and Latin Names (Public land to species level. Private land to genus level)
- *Health (Healthy, Stressed, Dead)
- *Leaf Area Index

*Features added from Machine Learning Algorithms using Ray Traced Point Cloud

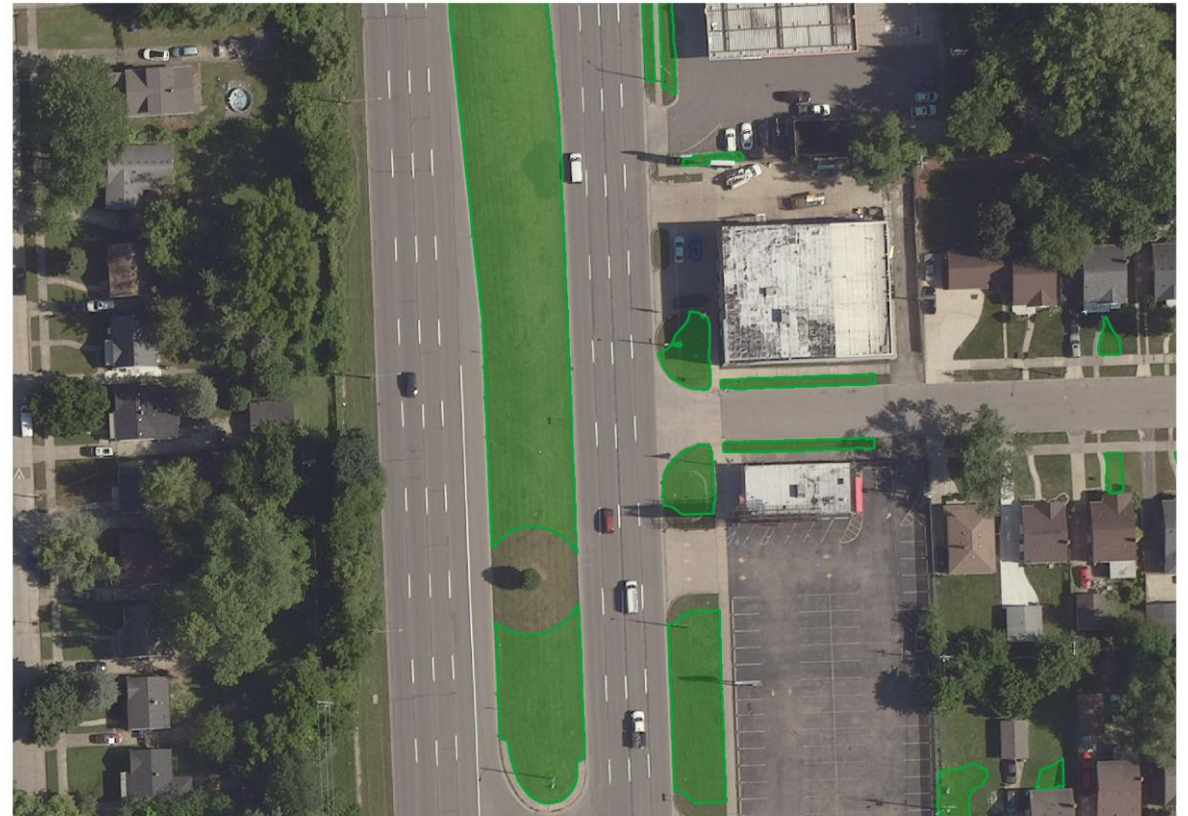
PHASE 3: LANDCOVER CLASSIFICATION - OPEN PLANTING SPACES

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Open Planting Spaces, ESRI Geodatabase

Attributes:

- Planting space ID
- Size
- Overhead wires
- Public (roadside/other) vs Private (from parcel data)
- Classify into major land cover classes
 - Tree
 - Shrub
 - Impervious
 - Grass
 - Water
 - Bare earth



Phase 4: GIS Support Tools

Environmental

Carbon Sequestration

- As of 2001, urban trees in the coterminous USA were estimated to have a gross carbon sequestration rate of 22.8 million tons of carbon per year (valued at \$460 million per year) (Nowak and Crane 2001).

Wildlife Habitat

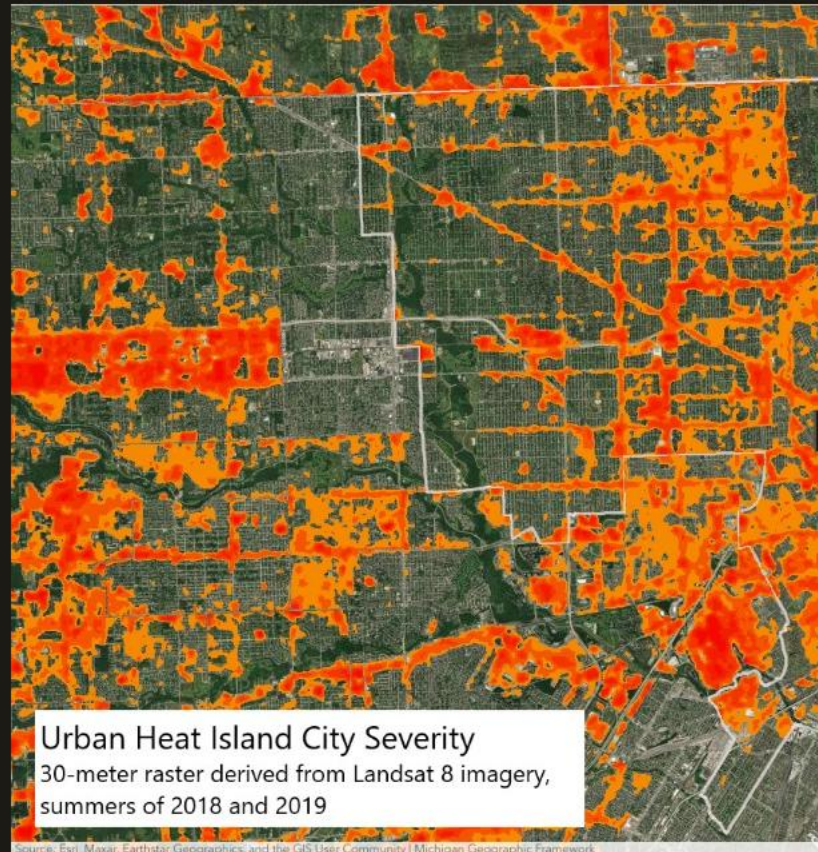
- More bird and arachnid species were found in trees in modified landscapes, including urban parklands and urban built-up areas, than in trees in reserves in Canberra, Australia (Le Roux et al. 2017).

Improved Air Quality

- In 2006, urban trees in 55 US cities were estimated to remove 711,000 metric tons (\$3.8 billion value) of air pollutants, including ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, and PM10 (particulate matter with a diameter of 10 micrometers or less) (Nowak, Crane, and Stevens 2006).

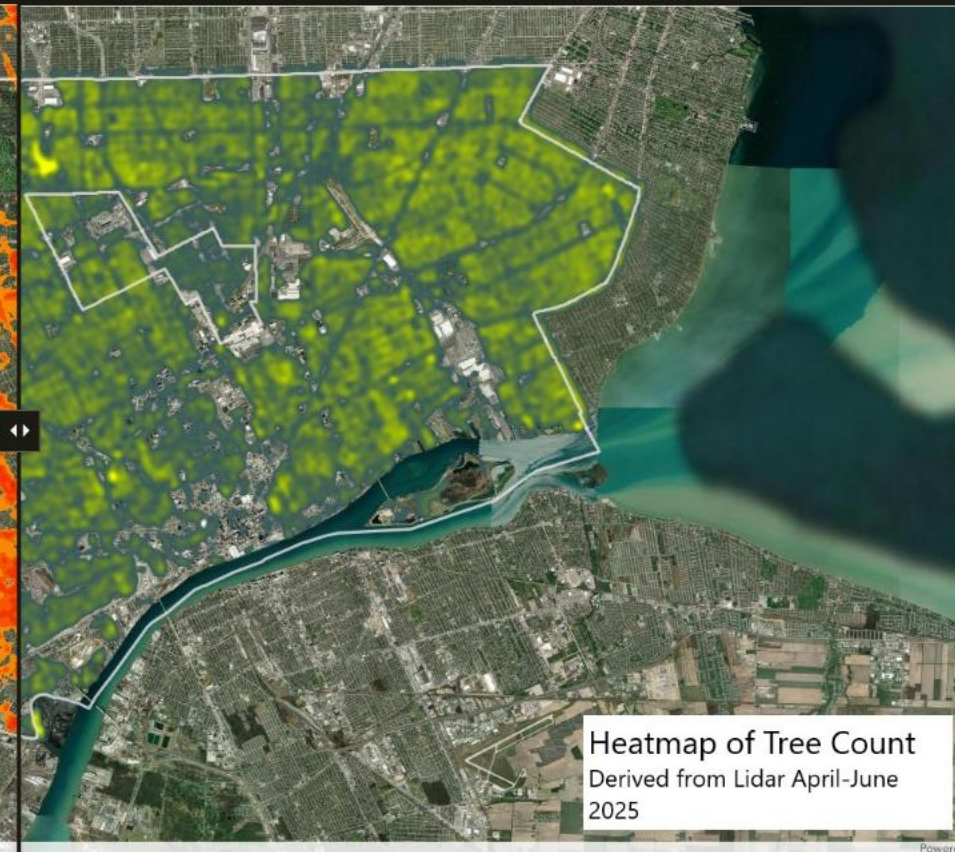
Reduced Stormwater Runoff

- Compared to a patch of asphalt alone, a patch of asphalt with



Urban Heat Island City Severity
30-meter raster derived from Landsat 8 imagery, summers of 2018 and 2019

Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community | Michigan Geographic Framework



Heatmap of Tree Count
Derived from Lidar April-June 2025


Powered

GIS Support Tools

- ArcGIS Online
- Scene Viewer (3D Web Map)
- StoryMaps
- Experience Builder
- ArcGIS Pro
- i-Tree Eco

i-Tree Software Center

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.



Tools for Assessing Individual Trees

- MyTree
- i-Tree Design
- i-Tree Eco (*Check for Updates*)

Tree Planting & Accountability Tools

- i-Tree Planting
- i-Tree Species

Additional Tools

[i-Tree Database](#) | [i-Tree Eco Project Sharing](#) | [Research Suite](#) | Powered by i-Tree | info@itreetools.org

Tree Canopy Assessment Tools

- OurTrees
- i-Tree Landscape
- i-Tree Canopy

i-Tree Support

- i-Tree Website
- User Resources
- About i-Tree

Trees provide more than just beauty and shade.

They 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.








They work hard for all of us, every day!

i-Tree needs YOUR help

Please credit i-Tree in your projects to help spread the word and [use our trademarked logos](#).

i-Tree relies on private & public funding to run and to develop new science and tools - contact us if you can help!

Since 2006, i-Tree has been a cooperative, public/private partnership between:

CITY OF DETROIT Tree Reporting Tool

1. Select a Neighborhood

Search

- Airport Sub (Council District 3)
- Arden Park (Council District 5)
- Aviation Sub (Council District 7)**
- Bagley (Council District 2)
- Barton-McFarland (Council District 7)
- Belle Isle (Council District 5)
- Belmont (Council District 1)
- Berg-Lahser (Council District 1)
- Bethune Community (Council District 2)
- Blackstone Park (Council District 2)
- Boston Edison (Council District 5)

2. Filter (optional)

In City of Detroit ROW

Foliage Type

Health

On DLBA-Owned Property

DLBA Status Type

Sale Status

3. View Report

[Click here to view](#)

Tree Report Details: Aviation Sub

Neighborhood Information

Council District: 7
Neighborhood Number: 200
Area: 301 acres (13,096,422 sq. ft.)

Tree Statistics

Count: 646 trees
Total Canopy Area: 3,252,391 sq. ft.
Average Height: 44 ft.
Healthy Trees: 588 trees
Stressed Trees: 46 trees
Dead Trees: 12 trees

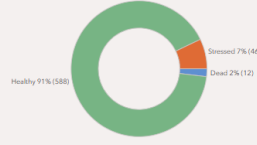
Location Breakdown

646 total trees in Detroit ROW (100%)
0 on DLBA property (0%)

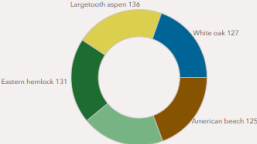
Value

Value of all trees: \$64,600
Carbon Sequestered: [Placeholder]
Runoff Mitigated: [Placeholder]


Health



Species



Frequency of Trees by Height





Detroit's Trees

The Beneficial Impacts of Urban Tree Canopy

September 4, 2025

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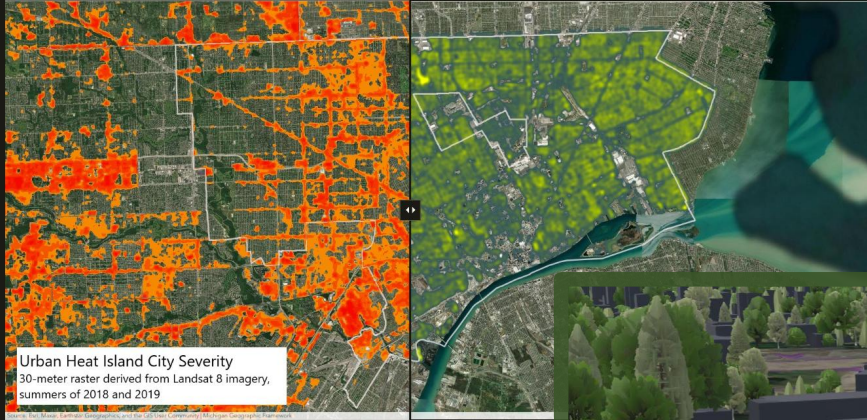
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1. Select a Neighborhood

Q Search

Airport Sub (Council District 3)

Arden Park (Council District 5)

Aviation Sub (Council District 7)

Bagley (Council District 2)

Barton-McFarland (Council District 7)

Belle Isle (Council District 5)

2. Filter (optional)

In City of Detroit ROW

Foliage Type

Health

On DLBA-Owned Property

DLBA Status Type

Sale Status

3. View Report

[Click here to view](#)

Click on a tree to learn more!
Search for an address, pick from a list of neighborhoods, or export info on a group of trees using the tools below.

Find a neighborhood

Search

Filter

Select and Export

2D Map

DLBA Layers

Future Planting Scenarios



About this species
[Report a problem](#) | [Contact Forestry](#)

Tree Report Details: Aviation Sub

General Information

District: 7
Census Number: 200
Area: 3,096,422 sq. ft.

Statistics

6 trees
3,252,391 sq. ft.
Height: 44 ft.
358 trees

Stressed Trees: 40 trees
Dead Trees: 12 trees

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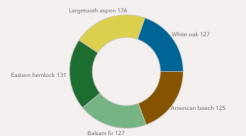
Value

Value of all trees: \$64,600
Carbon Sequestered: [Placeholder]
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Health



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RESULTS: HIGH LEVEL ANSWERS

Number of Trees in City

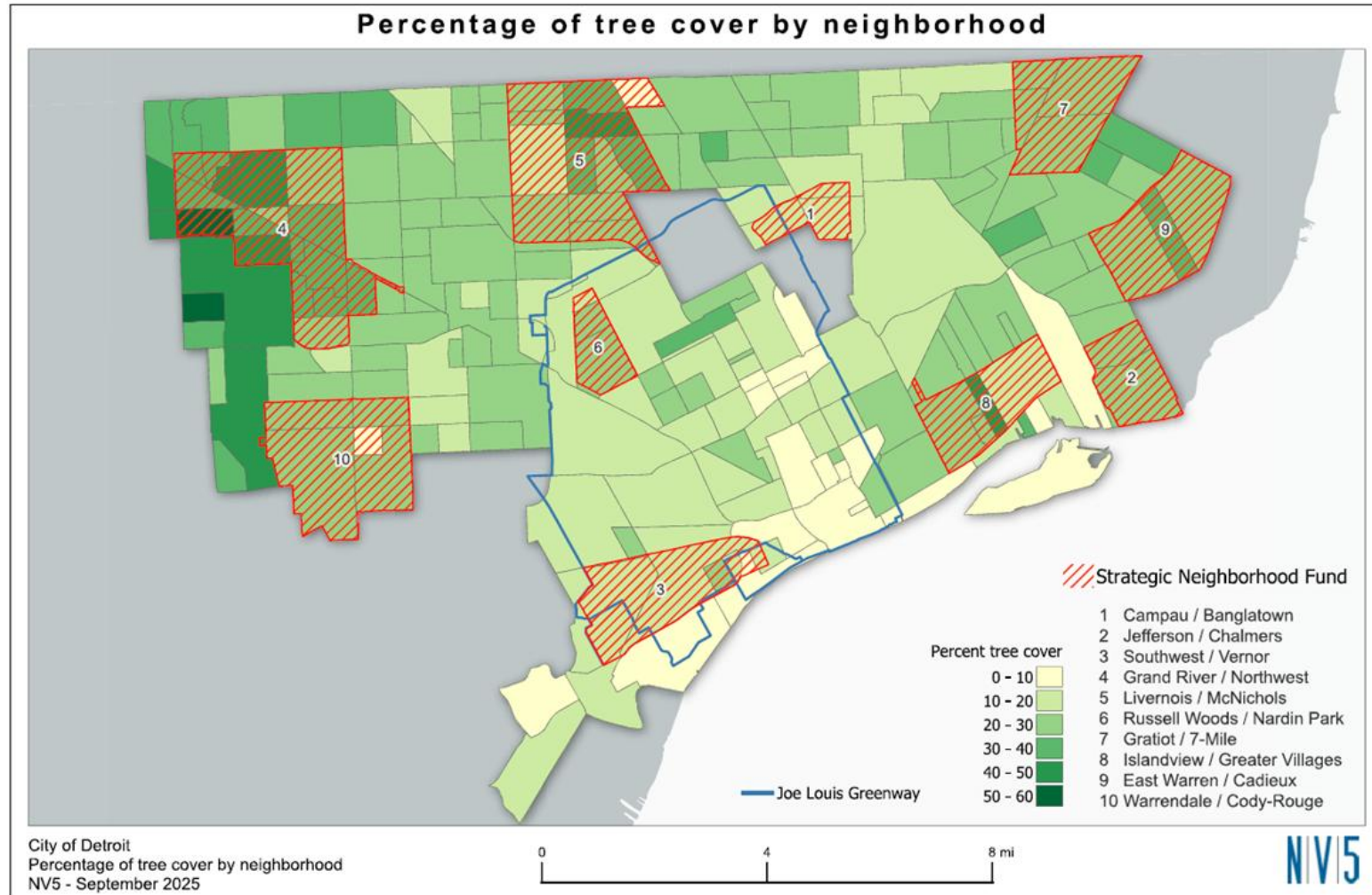
- ~1,555,271

Area

- Total Area: 88,946 acres
- Public Land: 30,498 acres
- Private Land: 58,448 acres
- Canopied:
 - Public - 22.1%
 - Private Land – 24.8%

Percentage

- Detroit has a canopy cover of 23.9%
- This varies greatly between neighborhood
 - Lowest - Waterworks Park 2.4%
 - Highest - Riverdale 57.3%



WHAT WE LEARNED

- This project has expanded our awareness of how many different groups contribute to Urban Forest Development
- This data provides an independent analysis of all trees and can be used to verify current tree databases that are used for management
 - Location of trees
 - Types of trees
 - Other errors
- It can also be used to unify all tree planting and management activities within a municipality
- Support educational opportunities and community engagement

THANK YOU



Kelsey Watkins
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