National Aeronautics and Space Administration

CENTRAL PARK ECOLOGICAL CONSERVATION

Assessing Tree Health Conditions in New York City's Central Park with Earth Observation Data

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DEVELOP

Pop-Up Project | Summer 2024

Meet The Team

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Central Park Conservancy

Mission: The preservation and celebration of Central Park as a sanctuary for all

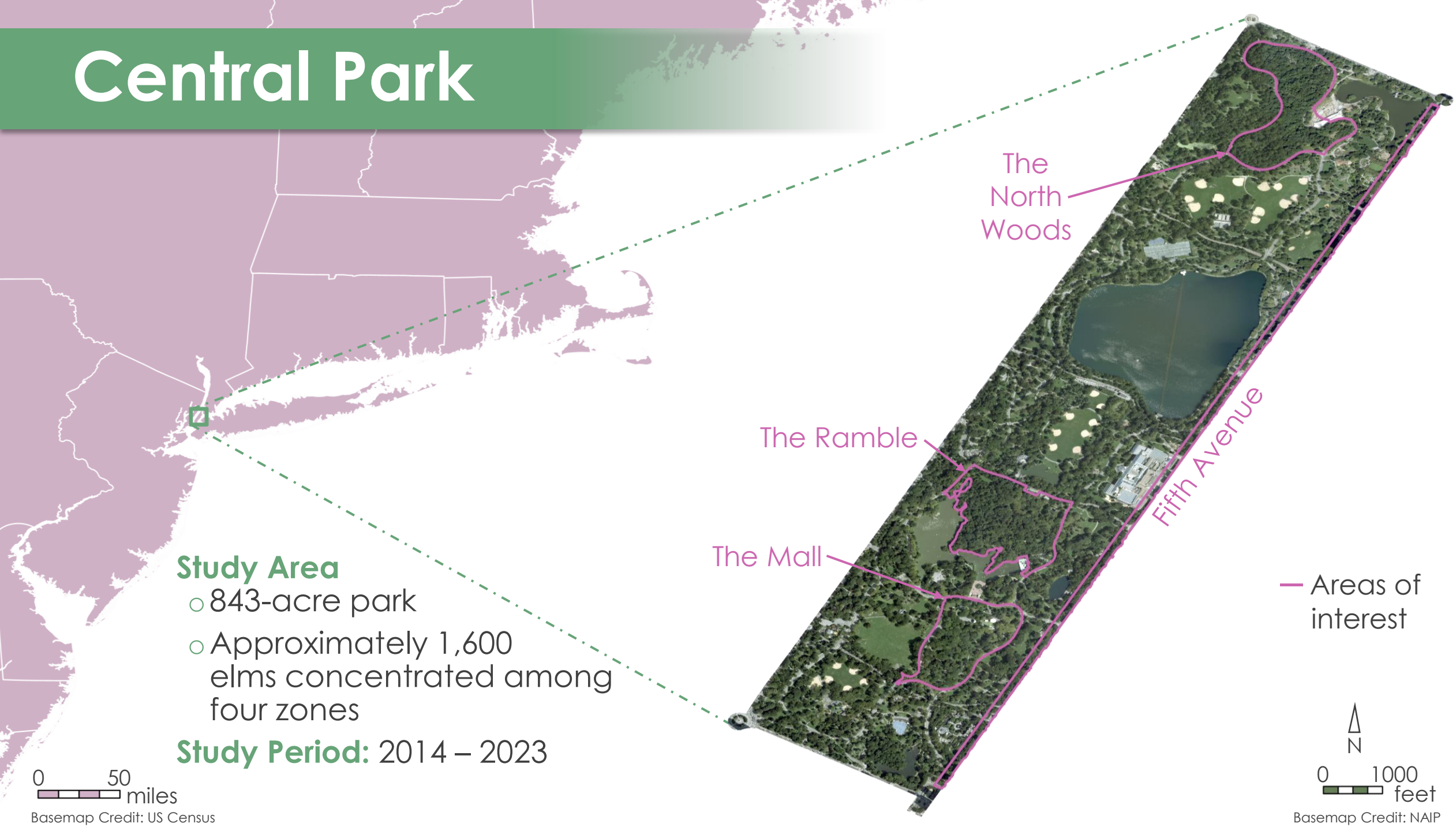
Image Credit: Central Park Conservancy

Community Concerns

Image Credit: Kayla Paramore

- **Preservation** of an urban ecosystem
- The iconic American elm **endangered** by Dutch elm disease (DED)
- Integration of remote sensing techniques to inform decisions about **forest** and **pest management**

Central Park



Study Area

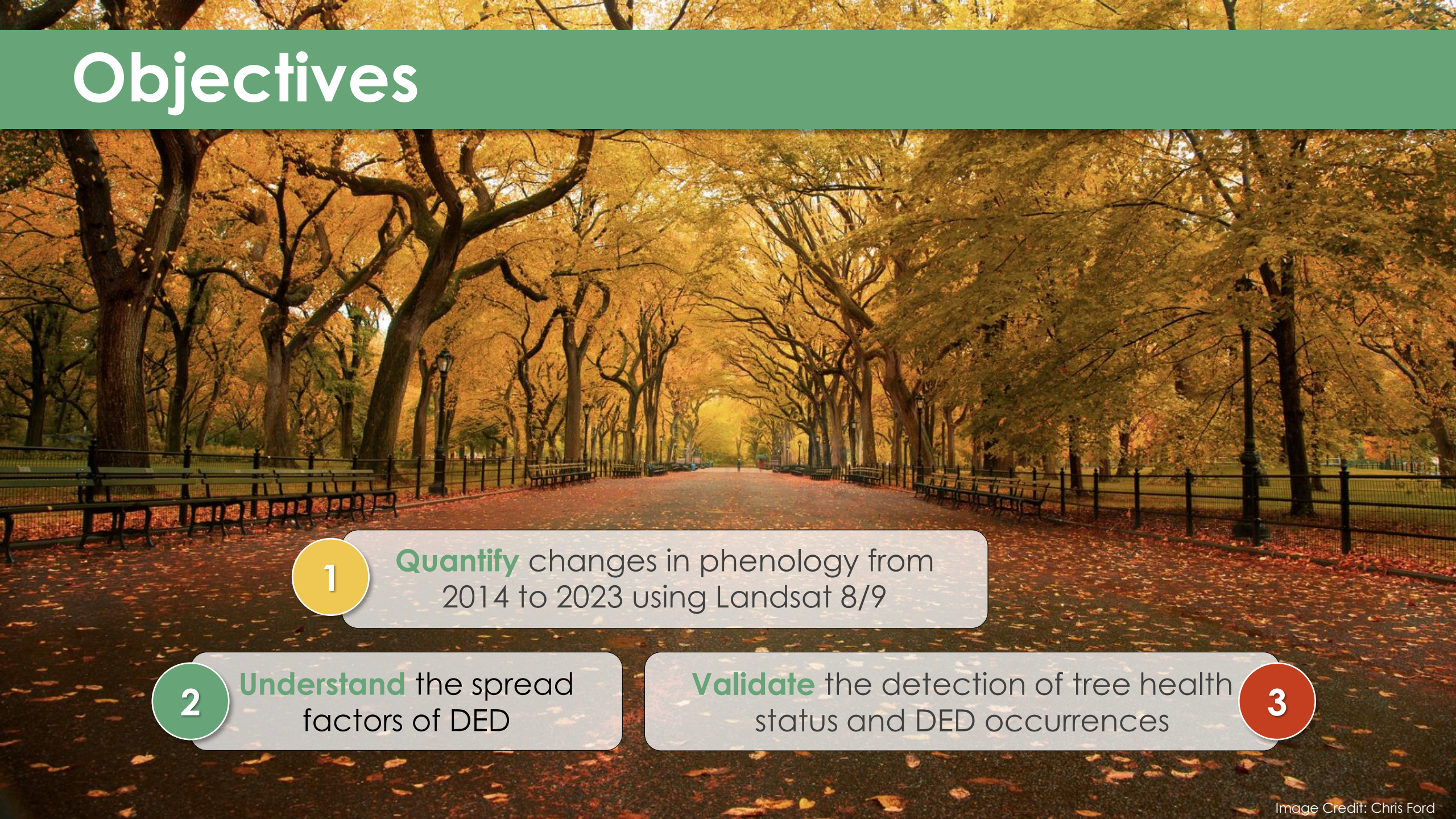
- 843-acre park
- Approximately 1,600 elms concentrated among four zones

Study Period: 2014 – 2023

0 50 miles

Basemap Credit: US Census

Objectives



1. **Quantify** changes in phenology from 2014 to 2023 using Landsat 8/9
2. **Understand** the spread factors of DED
3. **Validate** the detection of tree health status and DED occurrences

Image Credit: Chris Ford

Earth Observations

Landsat 9

Operational Land Imager-2 (OLI-2)

Landsat 8

Operational Land Imager (OLI)

Image Credit: NASA

Remote Sensing Data Products: NDVI

Normalized Difference Vegetation Index (NDVI)

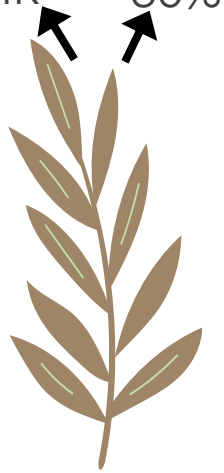
HEALTHY

50% NIR 8% RED

NDVI = 0.72

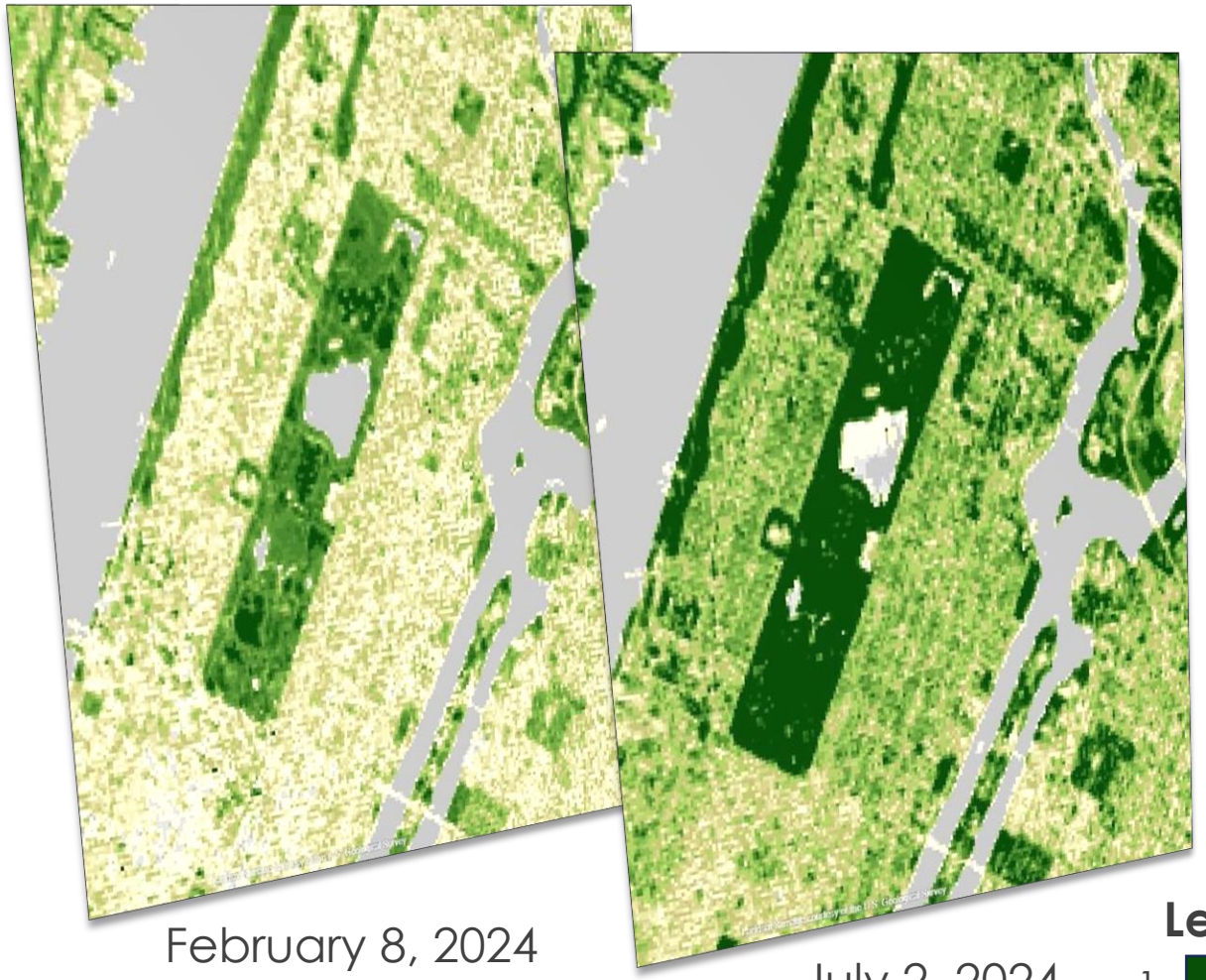
STRESSED

40% NIR 30% RED



NDVI = 0.14

$$\text{NDVI} = \frac{\text{NIR - RED}}{\text{NIR + RED}}$$



February 8, 2024

July 2, 2024

Image Credit: EO Browser

Icon Credit: Sketchify

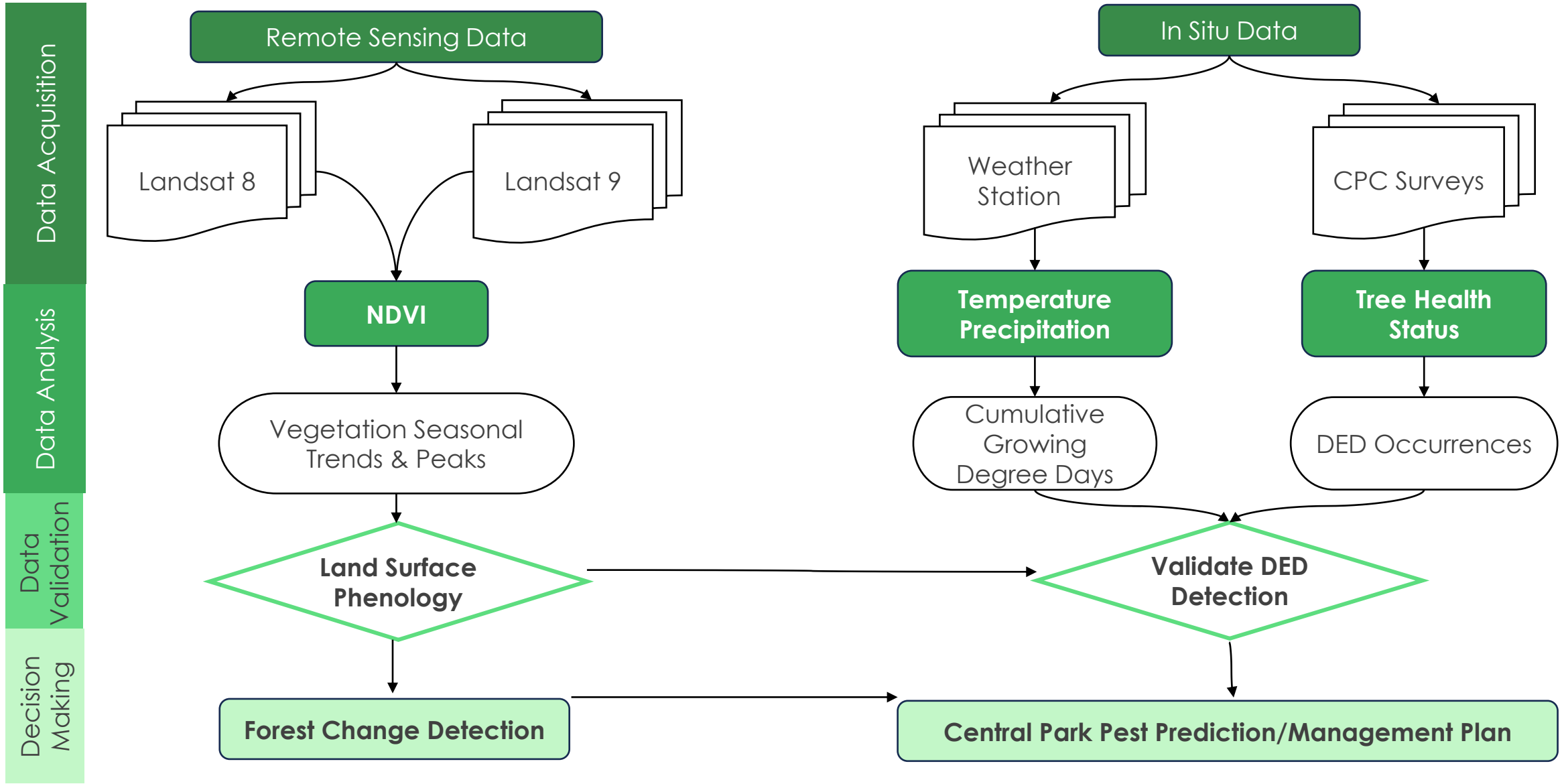
In Situ Data Products: Weather Data

Temperature

$$\textbf{Growing Degree Days (GDD)} = \frac{\text{Max Temp} + \text{Min Temp}}{2} - \text{Base Temperature}$$

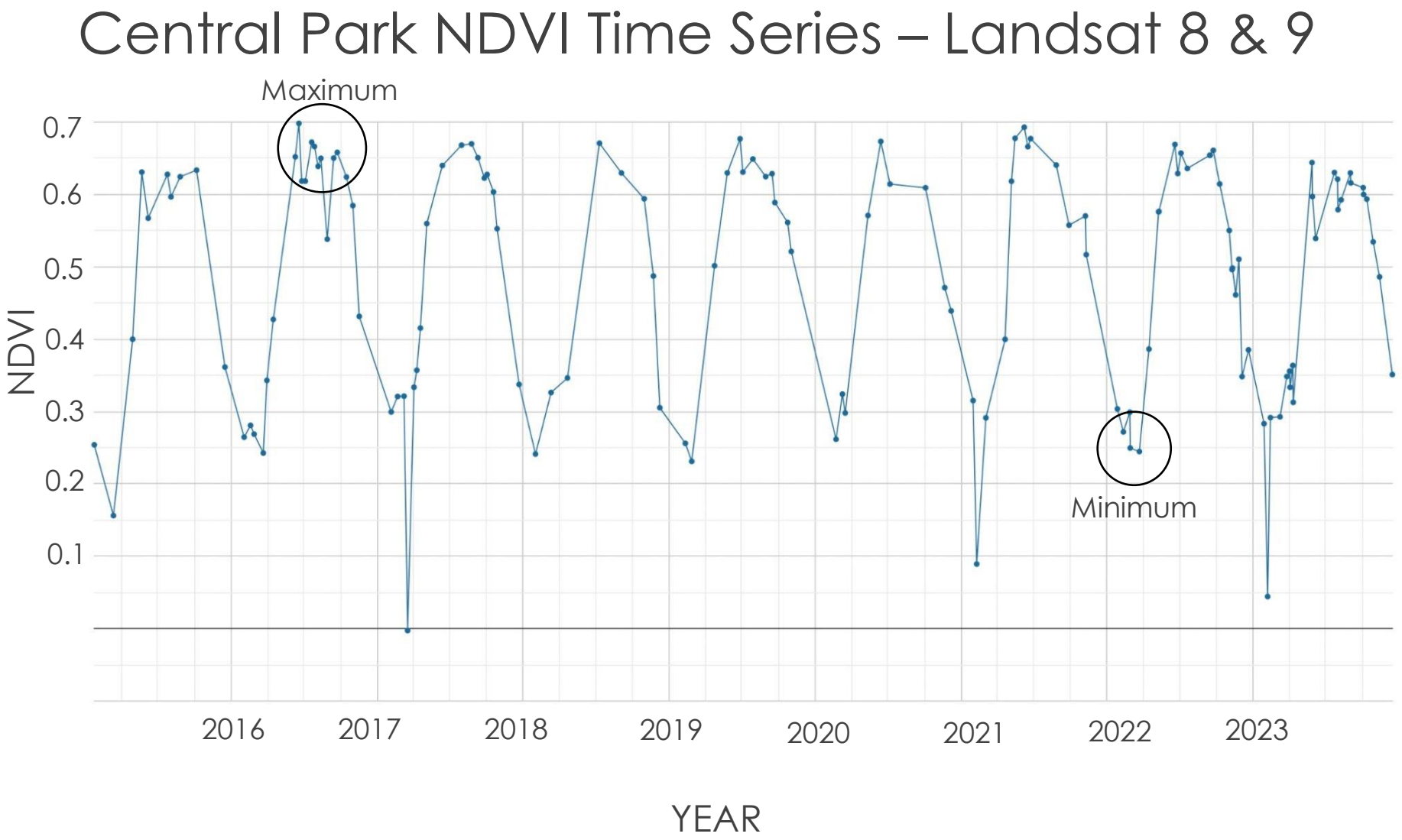
$$\textbf{Elm Bark Beetle GDD} = \frac{\text{Max Temp} + \text{Min Temp}}{2} - 52\text{F}$$

Methodology



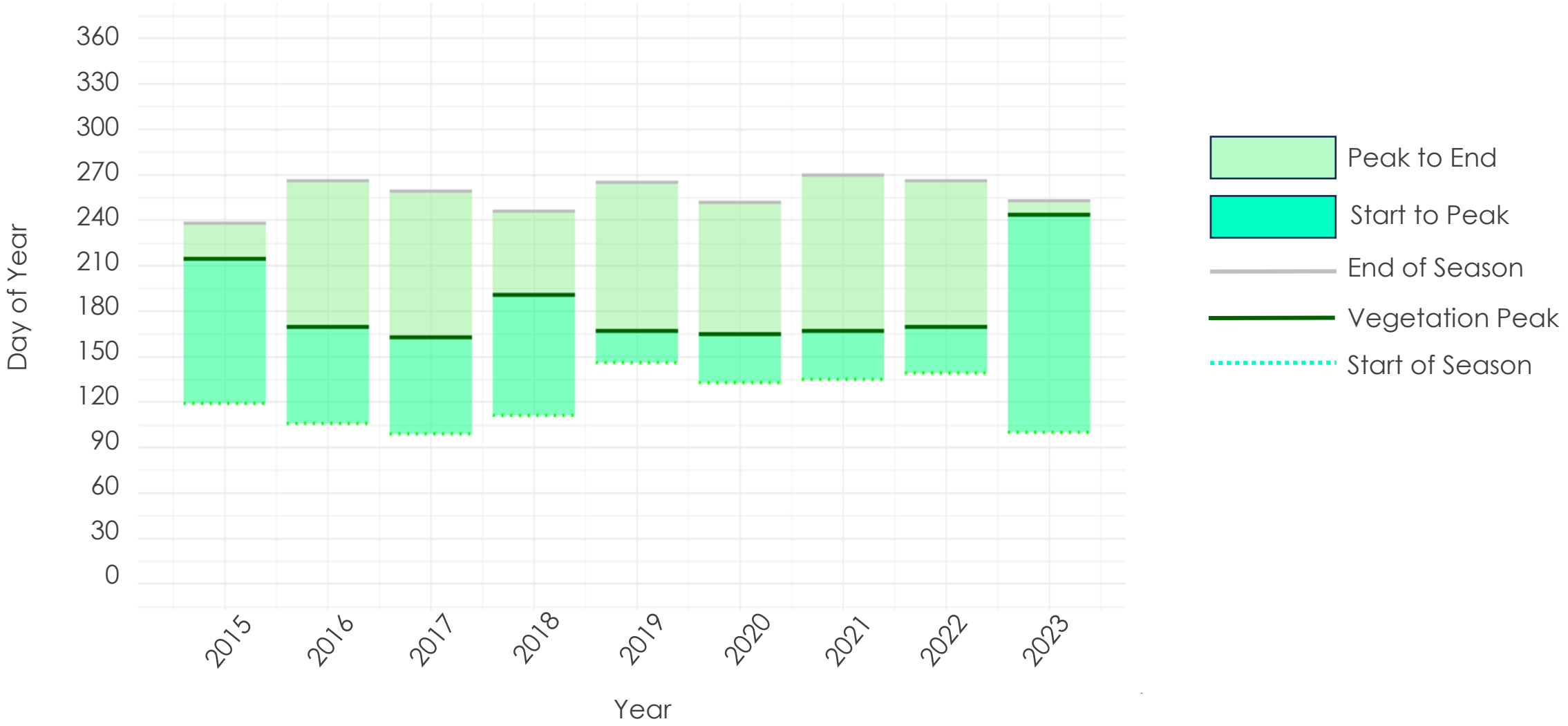
Results | Land Surface Phenology

Analyzing GIS data temporally by average pixel values



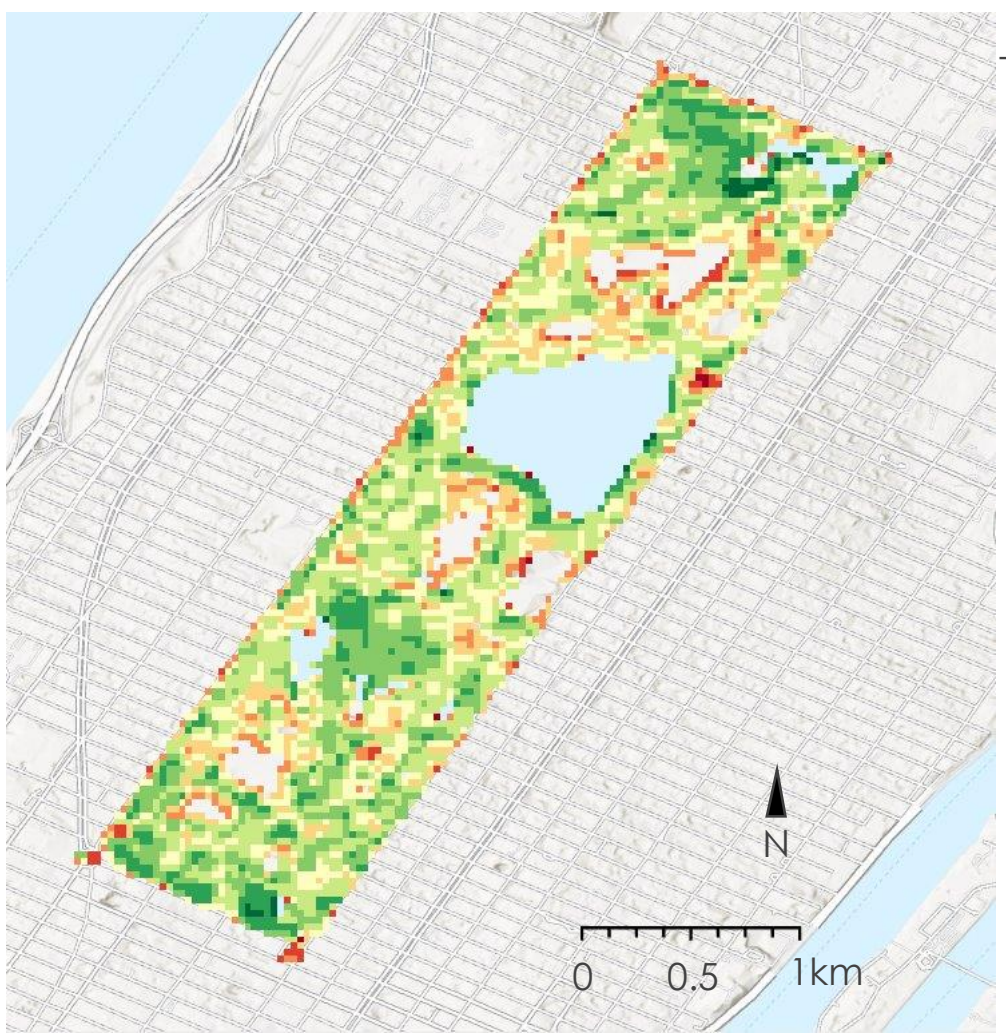
Results | Land Surface Phenology

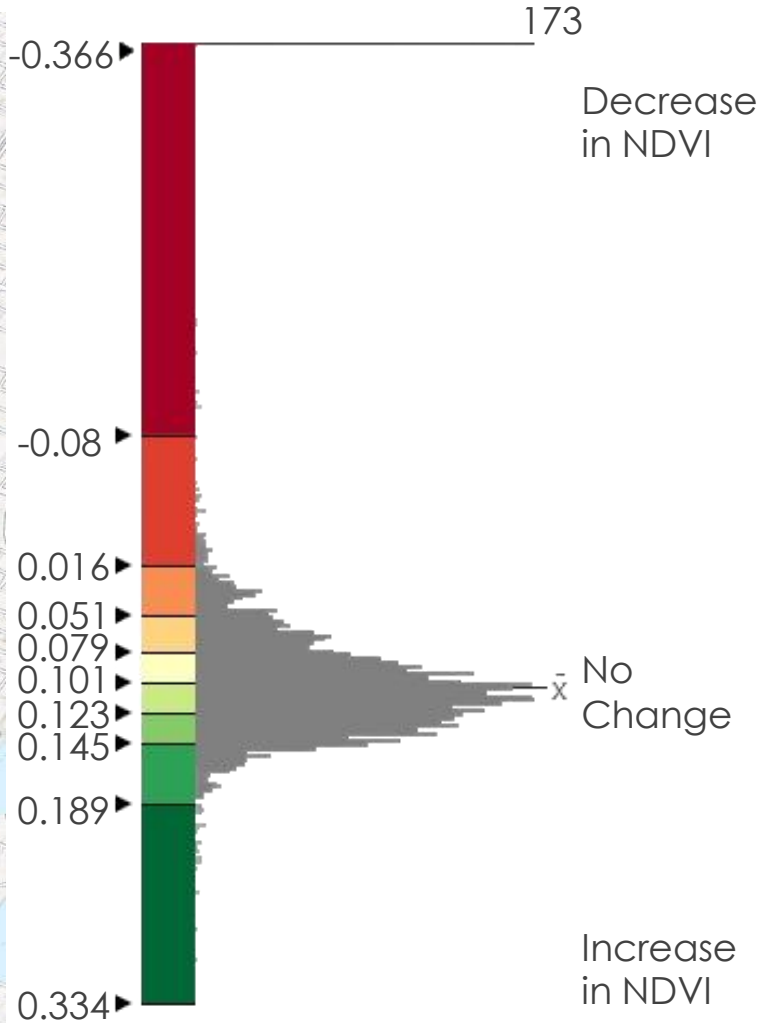
Estimated Growing Season and Peak Vegetation Days



Results | Land Surface Phenology

2019 Vegetative Season Compared with the 10-year Mean

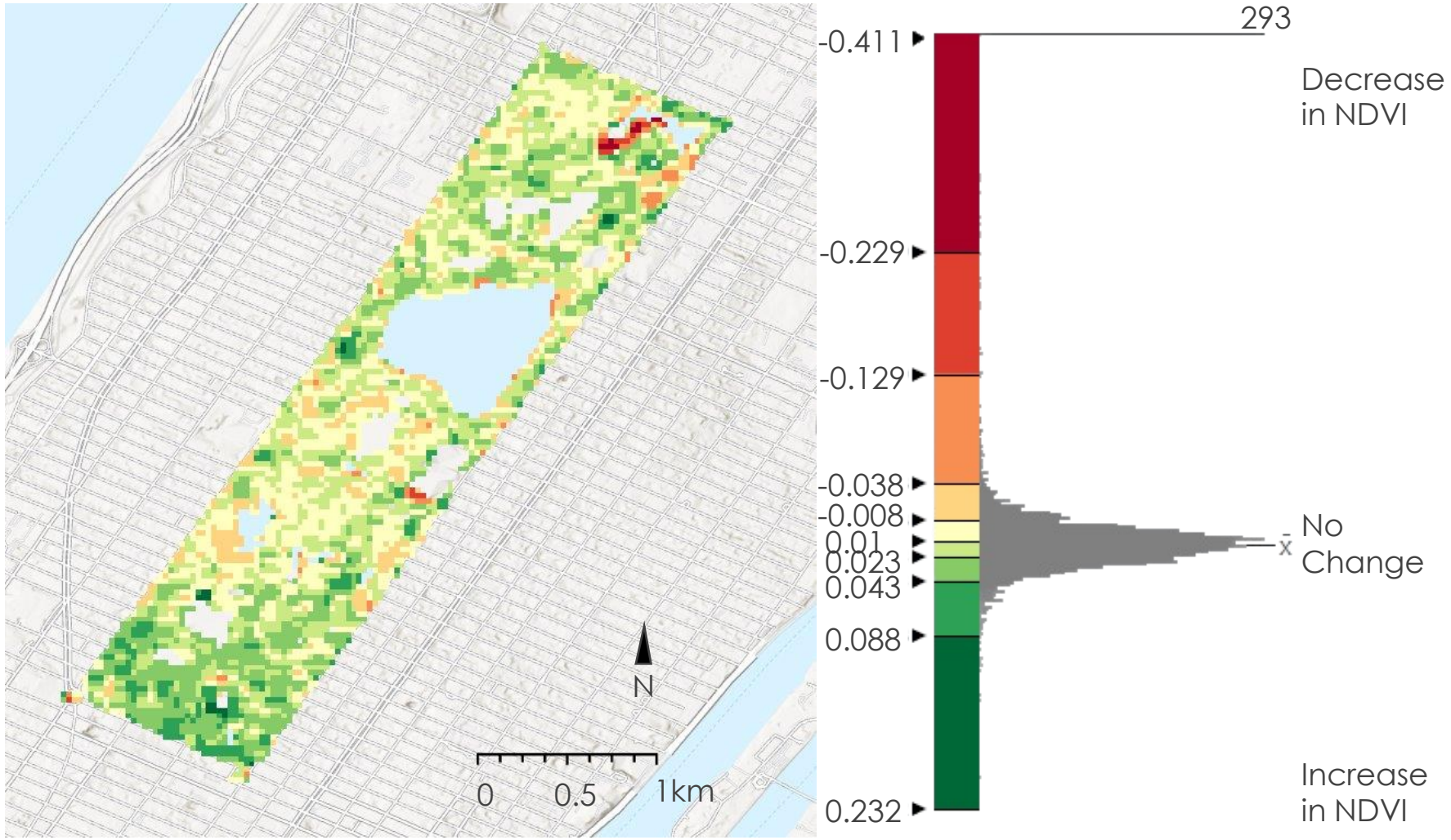




Basemap Credits: NYC OpenData, New Jersey Office of GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS,

Results | Land Surface Phenology

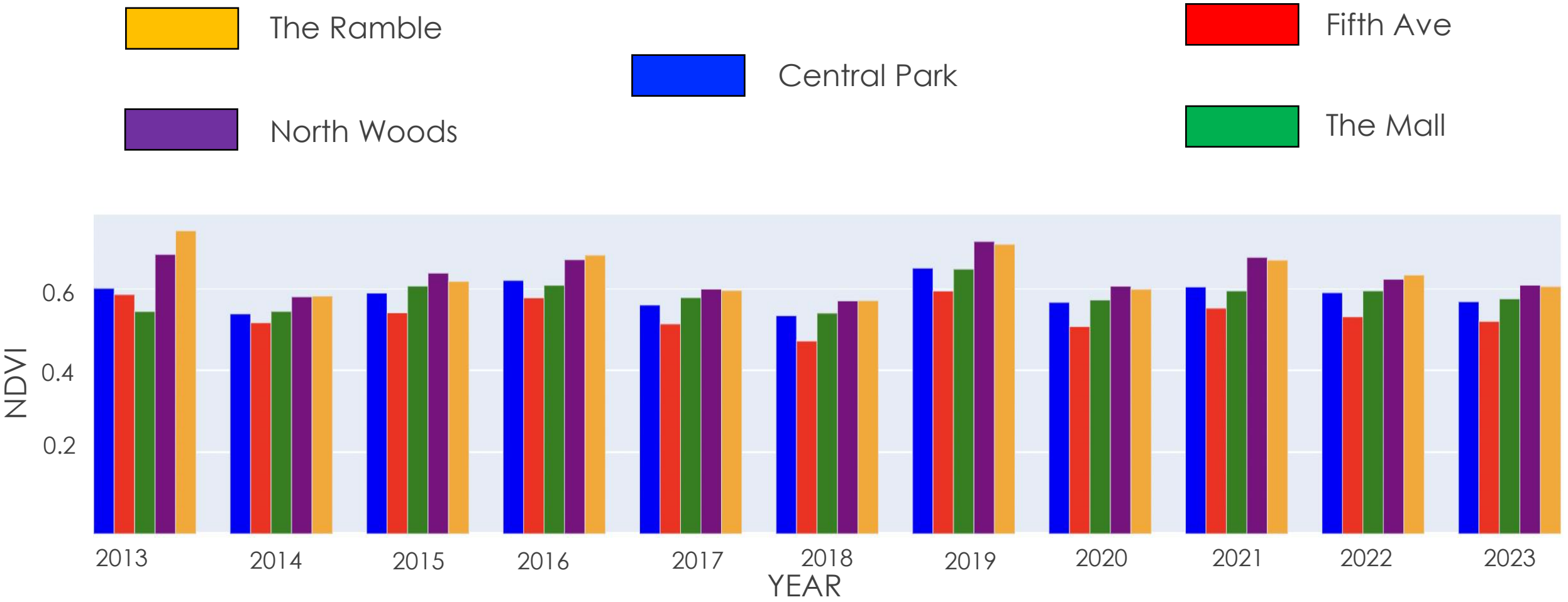
2023 Vegetative Season Compared with the 10-year Mean



Basemap Credits: NYC OpenData, New Jersey Office of GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS,

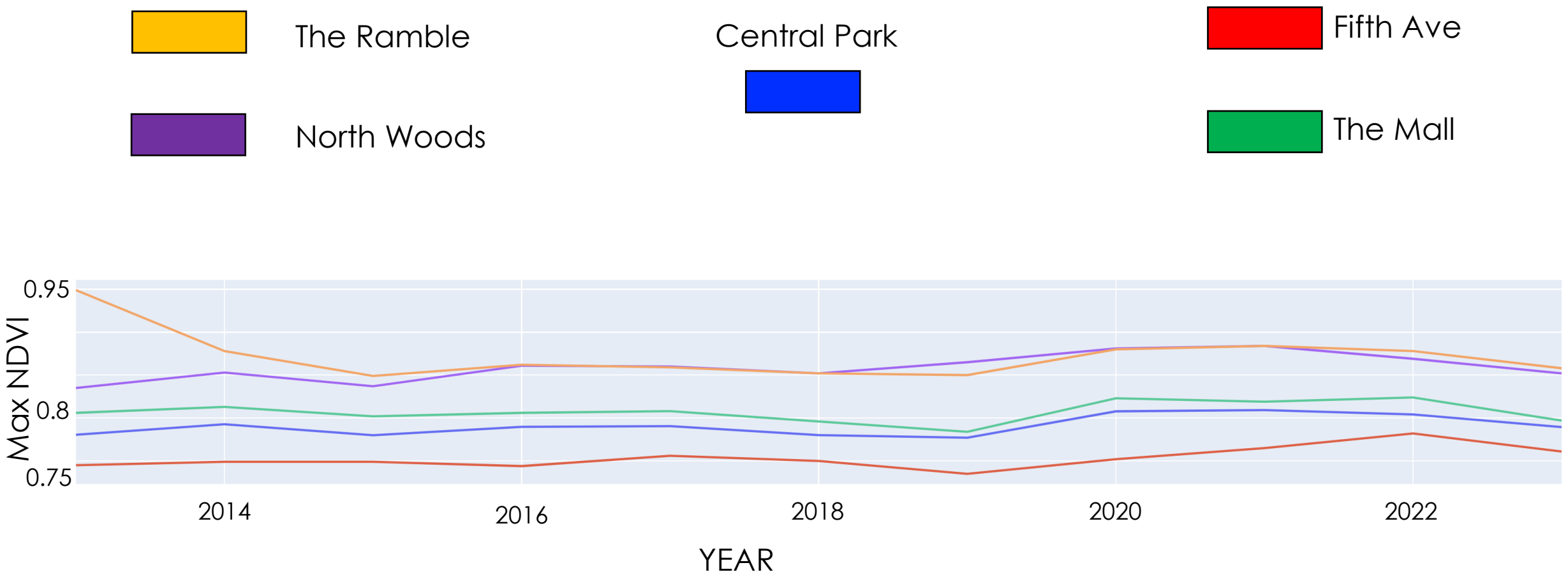
Results | Central Park Zones Phenology

Mean NDVI for Each Year by Zone

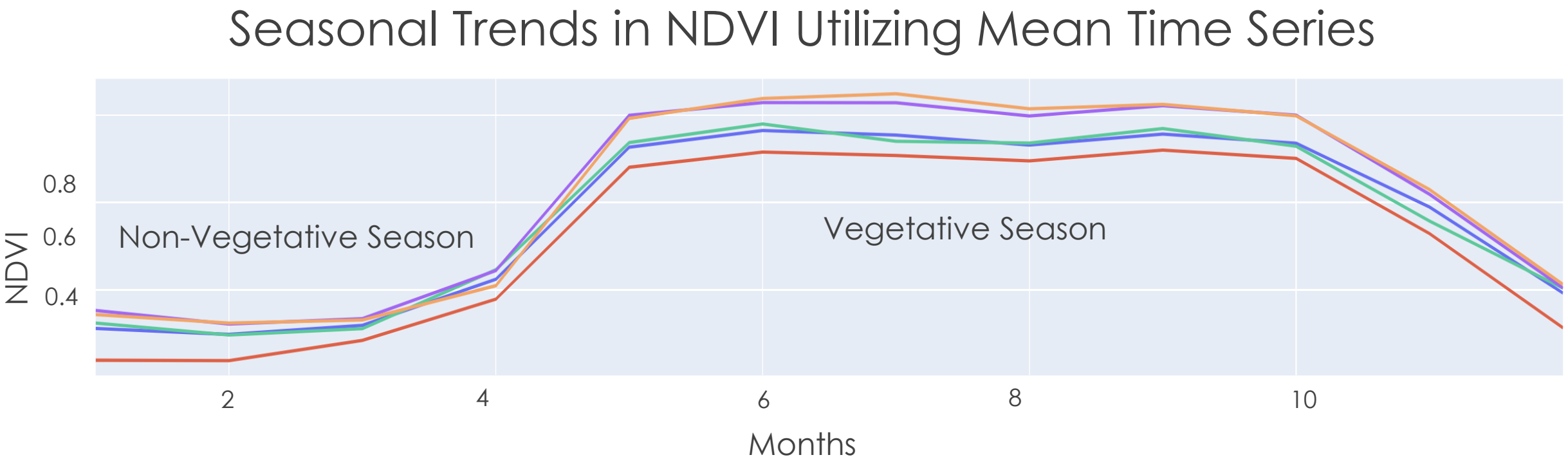


Results | Central Park Zonal Phenology

Max Zonal NDVI Over Time

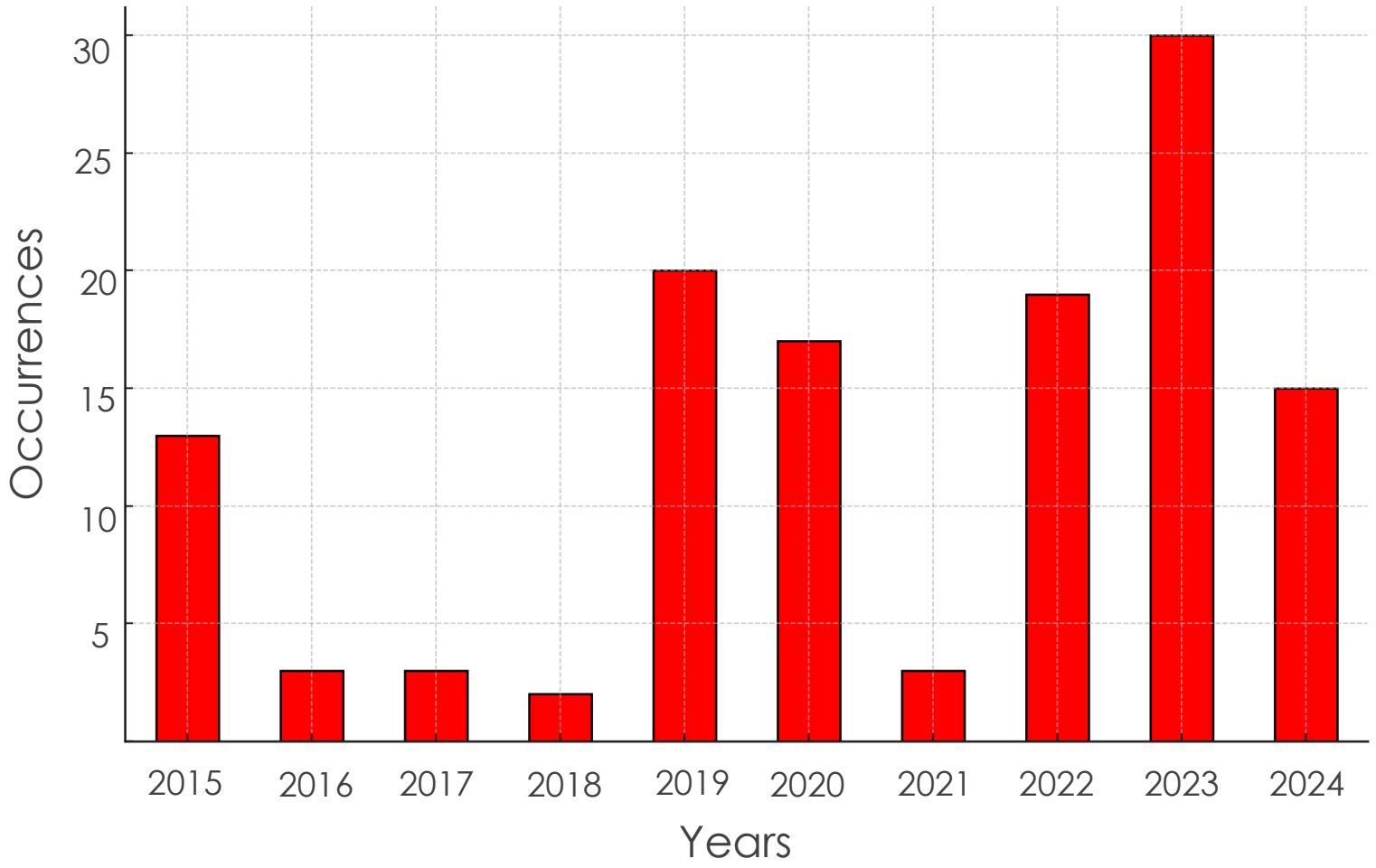


Results | Central Park Zones Phenology



Results | Dutch Elm Disease Spread

Elm Trees Affected by DED by Year for all of CP

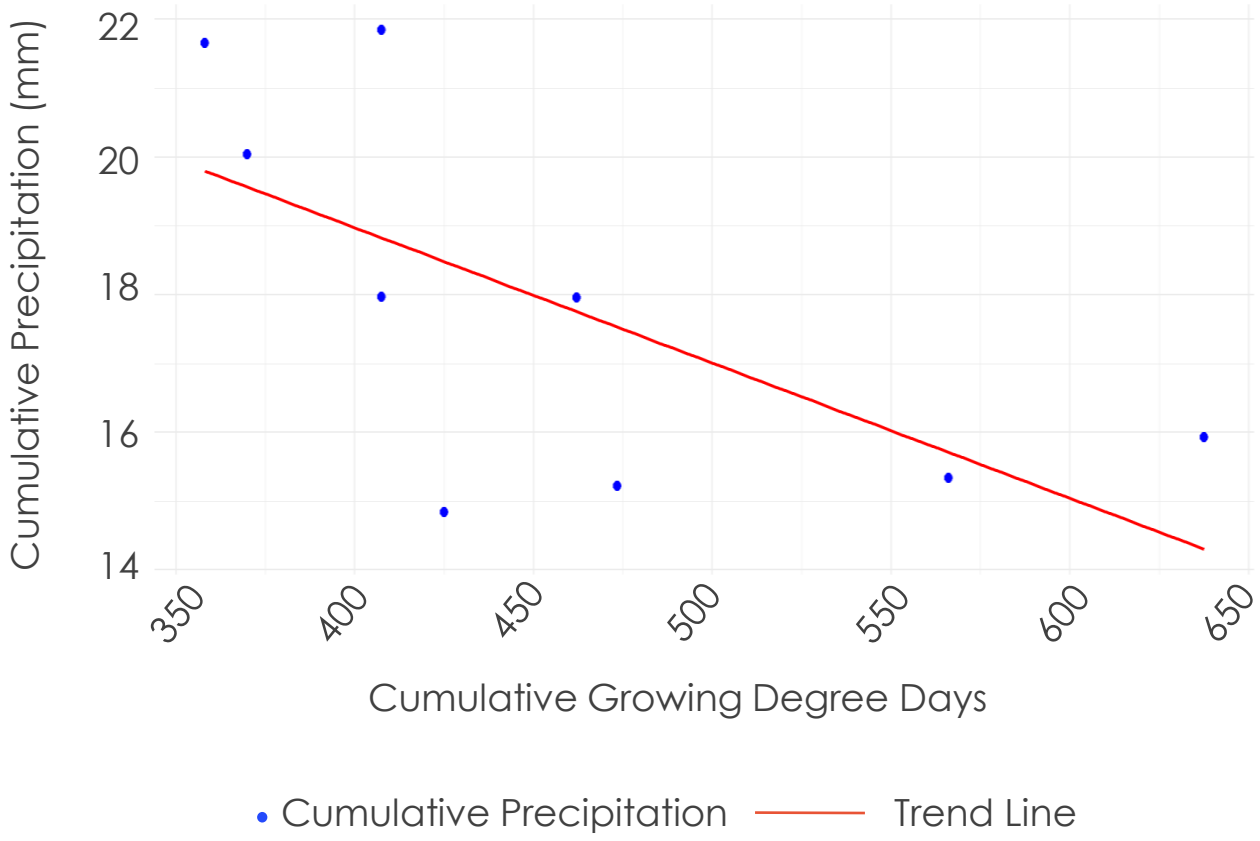


What is affecting this spread?

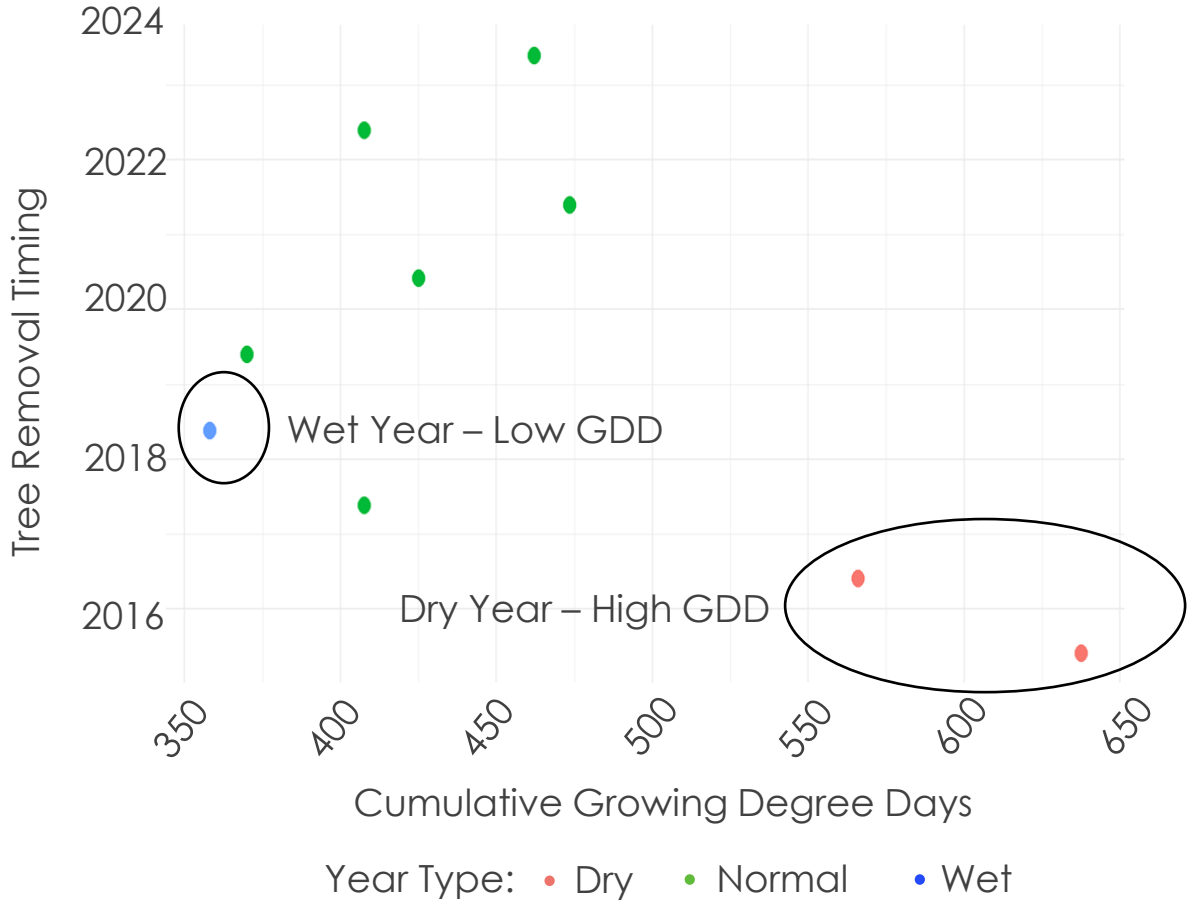
- Specific amount of cumulative growing degree days?
- Specific amount of precipitation?

Results | DED Spread Factors

Relationship between cGDD and Precipitation

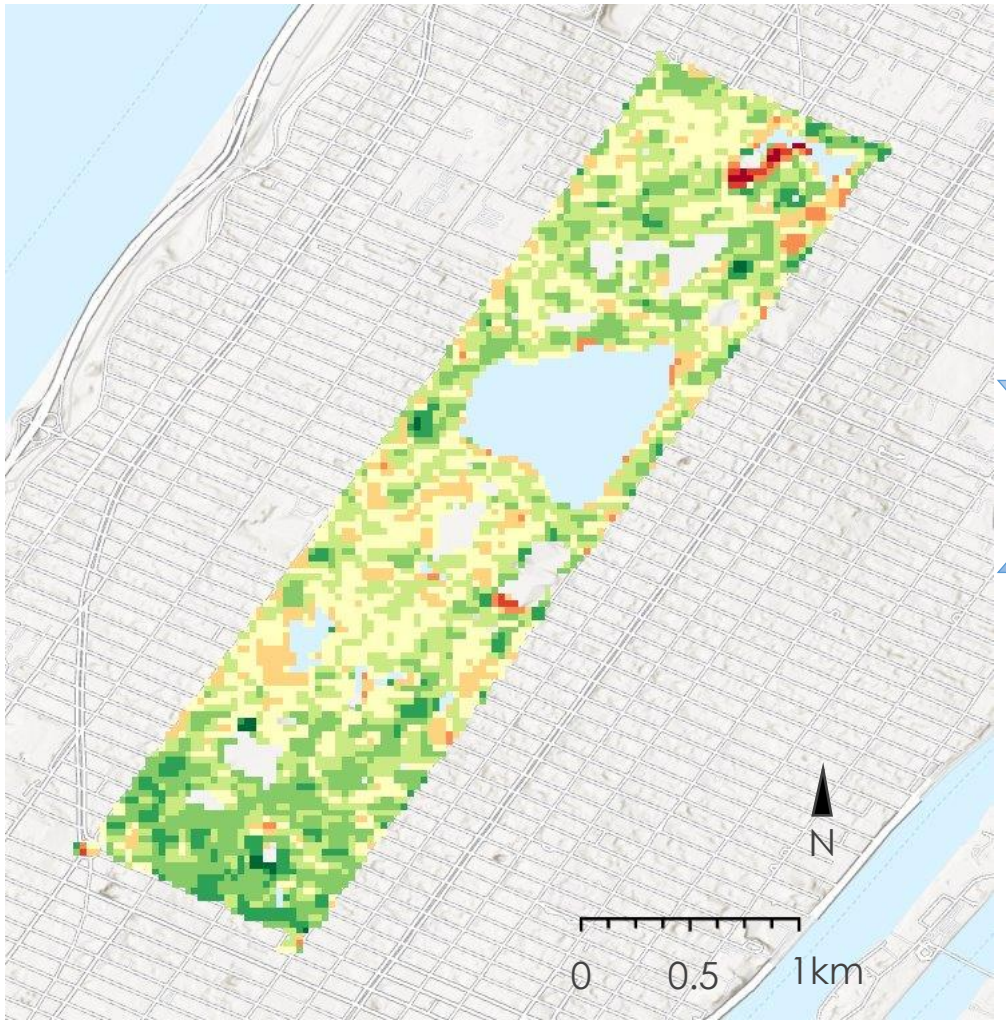


Validating the Relationship using DRY vs WET Year



Results | Pixel vs Mean Analysis

Analyzing GIS data temporally by pixel level analysis

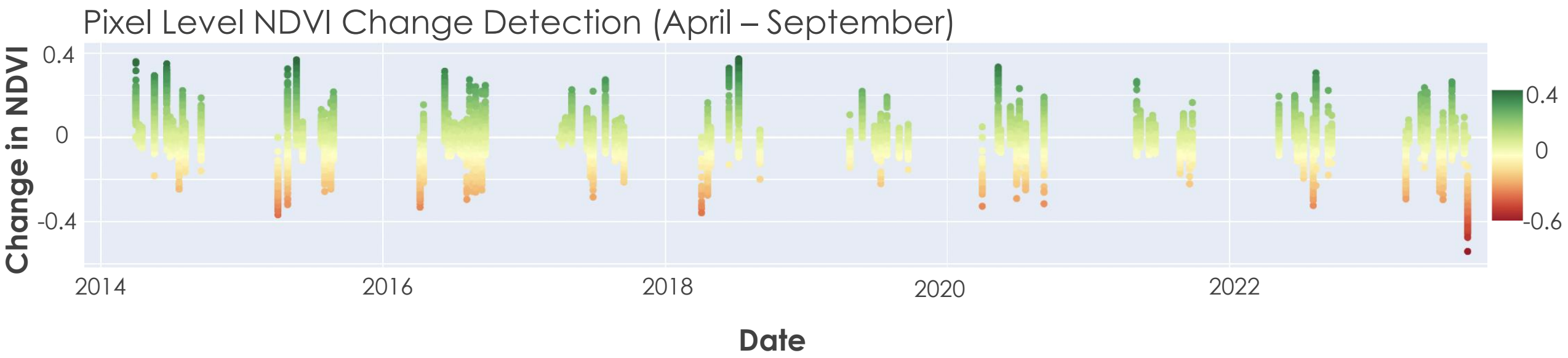


Basemap Credits: NYC OpenData, New Jersey Office of GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS,

Provide more details about the spatial variability:

30 m x 30 m

Results | Pixel Level NDVI Detection



Results | Validation – Logistic Regression

The validation of **Landsat 8 and 9** detection using the **in situ data** (CPC data):

NASA EO **detect unhealthy tree canopies** with **71%** accuracy and healthy tree canopies with **41%** accuracy

	Recall	Precision	F1. score
Healthy Tree Canopies	**0.47**	**0.37**	**0.41**
Unhealthy Tree Canopies	**0.67**	**0.76**	**0.71**

Errors & Uncertainties

Time

Assessing disease impacts alongside pest management interventions

Space

Accuracy of the validation and performance model

Methods

Natural spatial variability of forest phenology

Feasibility & Partner Implementation

- **NASA Earth observations** can be used to quantify changes in urban forest greenness phenology
- Through validation with in situ data, NASA Earth observations can detect unhealthy tree pixels
- Satellite-based forest health monitoring can be used with **phenology and DED surveys** to improve pest management decisions
- Further research is needed to further product validation and improve **predictive modeling** results needed to aid proactive management

Conclusions

1. Land surface vegetation greenness phenology fluctuates year to year

2. Differences in NDVI are distinguishable between different forested areas in the park

3. Pixel-based analysis validation results suggest show that Landsat 8 and 9 are potential methods for further assessing the relationship between DED occurrences and NDVI at the pixel level

Acknowledgments

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  - Yanina Kupava

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