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Mapping Urban Tree Canopy Change in the Columbus Park Neighborhood in Worcester, Massachusetts from 1952-2018

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Introduction

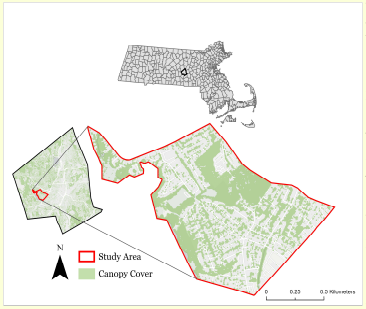


Figure 1. Study Area Map

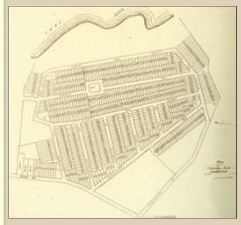
Urban tree canopy (UTC) across North America has been declining in recent years, making analysis and detection increasingly important. Nationally, Massachusetts currently ranks 11th in UTC loss per year (Nowak et al., 2018). Looking into the history of Worcester can help us better understand patterns behind UTC dynamics and the role of human impacts on tree canopy in a post-industrial city. Many different techniques are used to map UTC, often using high resolution satellite imagery. Aerial photographs, a type of remotely sensed data, have existed decades before satellites, providing a longer historical time frame of Earth's physical landscape. Thus, aerial imagery is useful in the field of urban ecology. In this study, we investigated historical UTC in the Columbus Park Neighborhood in Worcester, Massachusetts using historical aerial imagery from 1952 to digitize tree cover, and compared it with 2018 EarthDefine UTC from National Agriculture Imagery Program (NAIP) imagery.

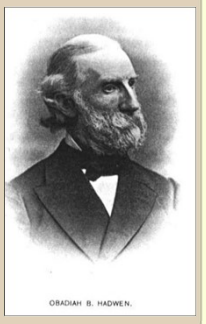
Research Objectives

- Calculate urban tree canopy change from 1952-2018
- Investigate any historical patterns in Columbus Park
- Find a realistic canopy cover goal for the neighborhood

Columbus Park: A Brief History

In the year 1892 contractors named Warden and Phelps purchased 68 acres of land just outside the more densely populated areas of Worcester which they would name Columbus Park. The earliest mention of the completed neighborhood was in 1900 when there were 400 residents. At this time, Columbus Park was an affluent community, and seen as the ideal place to live for the upper middle class. Since then, the name 'Columbus Park' refers to a larger area of 1.42 km² that includes the original section. Notable features include the Hadwen Arboretum, Norcross Mansion, and Coes Reservoir (see Figure 1).





The Hadwen Arboretum (entrance pictured above in 1900) is one of the most prominent features in Columbus Park. Formally the residence of Obadiah Hadwen, the land was gifted to Clark University in his will upon his death in 1907. The land used to be part agricultural as well as a space for many rare and nonnative species that Hadwen planted. However, Clark University did not actively manage the site. This trend in neglect of open space land was common in Columbus Park, especially between 1952-2018.

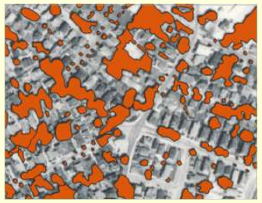
Methods

1) Georeferenced original 1952 aerial image of Columbus Park in ArcGIS

2) Digitized all tree cover from the 1952 image in QGIS

3) Created gain/loss/persistence map from the digitized 1952 UTC and 2018 UTC (EarthDefine)

4) Calculated various UTC metrics from the digitized polygons such as net UTC change and maximum saturation



Photos from a tree census of Columbus Park streets (summer 2021). Norway Maples were the most common species.

UTC Map (1952-2018)

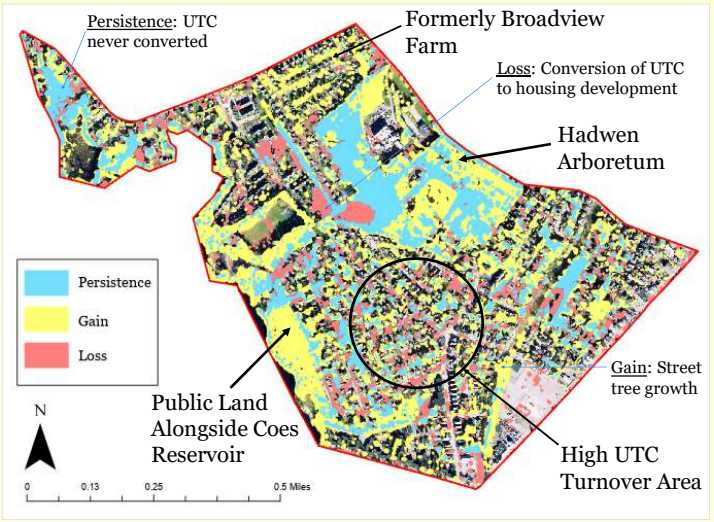


Figure 2. Urban tree canopy map showing gain, loss, and persistence from 1952-2018.

Results

Table 1. Final canopy cover metrics for Columbus Park.

Columbus Park	1952	2018	1952-2018 Net Change
UTC (m²)	408,823.6	644,415.6	+235,592
UTC (%)	28.74	45.31	+16.56

Between 1952 and 2018 the Columbus Park Neighborhood experienced a net increase in tree cover of over 16% (Fig. 3). Despite losing around 10% of its UTC, Columbus Park gained over a quarter of its land area in UTC resulting in the net value of 16.56% (Fig. 5). Much of the increase occurred in areas that were neglected such as the Hadwen Arboretum and the land owned by the City of Worcester alongside Coes Reservoir (Fig. 2). These neglected areas were once fields, farms or low lying vegetation that was left unattended, resulting often in forest growth.

Maximum Saturation: 55.6%
Maximum saturation shows the overall combined maximum extent of UTC from both 1952 and 2018. which is a good indicator of a realistic tree canopy percentage. Present day UTC is around 45% in Columbus Park meaning that with a maximum saturation of 55.6%, we can set a realistic canopy goal of a 10% increase in the near future.

Public Land:
-Of the 408,823 sq meters of urban tree cover in 1952, 22.4% was on public land
-Of the 644,415 sq meters of urban tree cover in 2018, 28.7% was on public land
*Public Land makes up 18.9% of the total land area of Columbus Park

Table 2. UTC percentage of street area including front yards.

Streets & Front Yards	1952	2018
UTC (m²)	84,542.7	122,051
UTC (%) of streets & front yards	26.79	33.42

Streets and front yards have increased in UTC partly due to new streets and conversion of Broadview Farm to residential (Fig. 2). Separate analysis of high UTC turnover areas found an opposite trend of 2% UTC loss.

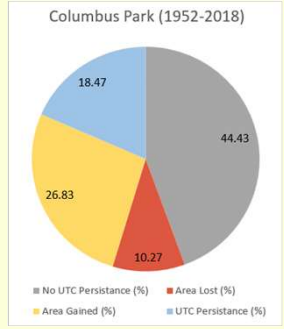


Figure 5. Pie chart showing total gain, loss and persistence

Major Findings

1. UTC has an overall net increase in Columbus Park from 1952-2018
2. Much of that increase is due to neglect
3. High amount of turnover in the central area of the neighborhood along streets
4. Public Land is overperforming based on its land size
5. A recommended realistic canopy goal for Columbus Park would be an additional 10%

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