2021

CITY OF SEATTLE

TREE CANOPY ASSESSMENT

FINAL REPORT

Findings prepared by City of Seattle Office of Sustainability & Environment

Analysis conducted by the University of Vermont Spatial Analysis Lab

ACKNOWLEDGMENTS

The 2021 Tree Canopy Assessment report was produced by the City of Seattle's Office of Sustainability and Environment using findings from a team led by the University of Vermont Spatial Analysis Lab.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

KEY TERMS AND ACRONYMS

Absolute change	The difference in two measurements over time. Absolute change = new value – original value.
Aerial imagery	Photography taken from an aircraft or other airborne device.
BIPOC	Black, Indigenous, and People of Color.
Conifer	Also called evergreen trees, trees that keep their leaf cover (which are typically needles or scales) year-round. Conifers grow slowly and generally live longer and provide more ecosystem benefits than deciduous trees.
DSH	Diameter at standard height, a standard method for measuring trees. Generally assumed to be 4.5 feet above ground level.
Deciduous	Trees that lose their leaves annually.
Evapotranspiration	Phenomenon that occurs when the sun hits a tree's canopy, causing water to evaporate from the leaves. This cools the area around the tree and reduces the amount of energy left to warm the air.
GSP	Green Seattle Partnership. A public-private venture dedicated to promoting a livable city by re-establishing and maintaining healthy forested natural areas.
Heat island	Urbanized areas that experience higher temperatures than other areas due to concentrations of buildings and other infrastructure. These areas absorb more heat than natural landscapes due to the materials they are made of (e.g., concrete, pavement, etc.).
Large tree	In this assessment, large trees are those estimated to have a DSH of 30 inches or greater.
LiDAR	Light Detection And Ranging. A remote sensing technology that uses beams of pulsed light fired from aircraft to create three dimensional models of the earth's surface.
Management unit	The City of Seattle categorizes trees and land into urban forestry management units (MUs), including: 1. Neighborhood Residential 2. Multifamily 3. Commercial/Mixed Use 4. Manufacturing/Industrial 5. Major Institutions 6. Downtown 7. Developed Parks 8. Parks Natural Areas 9. Right of Way These MUs are based on physical characteristics, management responsibility, and geographic location.

Net change	The sum of gains and losses in acres of canopy cover expressed as one number.
Relative change	A measurement of the magnitude of change between two values, expressed as a percentage of the original value. Relative change = (new value – original value) ÷ original value
RSE Index	Racial and Social Equity Composite Index, developed by the Seattle Office of Planning and Community Development. This tool includes data on race, language, origin, socioeconomic disadvantage, and health disadvantage, and divides census tracts into categories based on their level of disadvantage. In this report, we use the 2019 RSE Index.
Right of way	Public right of way is land dedicated for public use for the purpose of transportation, such as roads, sidewalks, and bike paths. It is a strip of land that allows the public to pass through or use an area without permission from the adjacent property owner. The right of way can be maintained either by the adjacent property owner or the City. Throughout this report, the term is not capitalized when referring to the right of way in general, and it is capitalized when referring to the specific associated urban forestry management unit.
Second-growth forest	Forest that has regrown after clearing or timber harvest.
Carbon sequestration	The process of capturing and storing carbon dioxide from the atmosphere.
Stormwater runoff	Stormwater runoff is generated from precipitation events, when rain that flows over impervious surfaces—hard surface such as concrete that do not absorb water—picks up harmful pollutants and sediments as it travels to bodies of water.
Tree canopy	The layer of leaves, branches, and stems that provide tree coverage of the ground when viewed from above.
Urban forest	Seattle's urban forest consists of the trees and associated understory plants existing in the city. The urban forest extends across public property, private property, and the right of way including parks and natural areas, as well as the trees along streets and in yards.

EXECUTIVE SUMMARY

THE IMPORTANCE OF TREES

Trees are a critical part of Seattle's infrastructure and fundamental to the character and quality of life in our growing city. Our urban forest is a valuable asset that provides ecological, economic, and social benefits: it supports public health, provides habitat for wildlife, sequesters carbon and absorbs pollution, helps manage stormwater, and provides spaces for exploration and enjoyment. These wide-ranging benefits help meet the City's health, equity, and climate resilience goals.

Our vision for the urban forest is a Seattle where everyone—starting with those most harmed by current and existing racial inequities—has access to trees and the benefits they provide, and where we keep our trees and forest healthy and thriving in the face of a changing climate. Part of this vision is achieving our goal of at least 30% canopy coverage that is equitably distributed across the city by 2037.

Seattle's tree canopy includes trees in public spaces like parks, natural areas, and the right of way, private land like neighborhoods and residential zones, and spaces like universities or the Arboretum. In 2016, the City of Seattle completed our first LiDAR-based tree canopy assessment to measure the extent of our urban forest. The findings in this current assessment come from data gathered in 2021 and allow us to understand how our urban forest has changed over those five years. We will use this information to inform and adapt our urban forest management strategies into the future.

KEY FINDINGS

Based on this assessment, we know the following about changes and trends in our urban forest:

- **We are slowly losing ground.** Seattle's 2021 canopy cover is 28.1%, down from 28.6% in 2016.[1] Seattle lost 255 acres of canopy (net) between 2016 and 2021—a relative decline of 1.7%, which equates to an area approximately the size of Green Lake (the lake itself).
- **Canopy loss is not happening equitably.** Neighborhoods impacted by racial and economic injustice not only started with less canopy but also lost more than the citywide average.
- **Trees are critical climate infrastructure, helping to mitigate extreme heat.** Trees help our communities adapt to a changing climate, protecting us from extreme heat. On hot days, temperatures are higher in areas with lower canopy cover.
- **Forested parks and residential areas saw the greatest net losses**. All urban forestry management units lost canopy, led by Neighborhood Residential and Parks Natural Areas. Combined, losses in these two management units account for 78% of the total canopy loss during the assessment period.

RECOMMENDATIONS

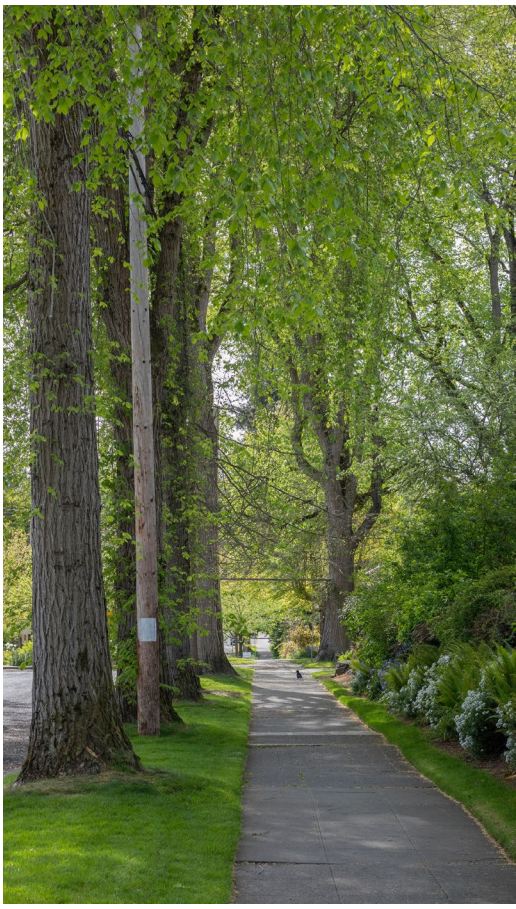
To reverse this downward trend and achieve our vision of an equitably distributed tree canopy in Seattle, we must pursue a variety of innovative actions. This report includes the following recommendations:

- Expand and deepen partnerships to plant new trees on both private and public property—focusing specifically on environmental justice priority areas—and plan for and fund their establishment and long-term care.
- Prioritize protecting and caring for the trees we already have, since preserving existing tree canopy is the most effective way to ensure future tree canopy.
- Incorporate current and expected future climate change impacts into our planting and maintenance practices to proactively respond to challenges like more heat, less water, and new and more prevalent pests and diseases.
- Continue to implement a strong regulatory framework that aligns our goals for tree preservation and protection with housing production and development needs for our growing city.

[1] In the 2016 Canopy Cover Assessment, Seattle's tree canopy was reported as 28% canopy citywide. The land cover mapping performed for this 2021 canopy assessment was done at a finer resolution due to having higher quality aerial imagery and LiDAR data available. This resulted in an updated determination of the canopy present in 2016. This assessment shows that there was 28.6% canopy cover present in 2016 rather than 28%.

BACKGROUND

SEATTLE'S VISION FOR OUR URBAN FOREST



Wooded parks, tree-lined streets, backyard hideouts, the sounds of birds on forested hiking trails. Trees are the star players in many favorite Seattle places. The urban forest is all around us—on public property like parks and natural areas, on private property like yards, and in the right of way along streets and boulevards. Our urban forest is fundamental to the character of Seattle and to our quality of life, especially as the city continues to grow. Our urban forest—trees, shrubs, and other plants—represents a valuable asset that provides ecological, economic, and social benefits. It helps define the character of the city, supports Seattle's public health, provides habitat for wildlife, and offers spaces for exploration and enjoyment.

Trees are a beloved and increasingly critical aspect of our urban infrastructure. Much of the way we currently conceive of and engineer solutions to manage environmental problems like stormwater runoff, air, soil, and water pollution, extreme heat, and carbon emissions is through static "grey infrastructure" in the built environment. These structures are usually stationary, require significant upfront investment, are expensive to maintain over time, and can't readily scale or adapt to the unpredictable shifts in the problems they were designed to solve. Trees on the other hand are more easily distributed and address multiple environmental challenges simultaneously, reducing the urban heat island effect, absorbing carbon and other pollutants, and managing stormwater.

As our city grows, so should our urban canopy. Our vision is a Seattle where everyone—starting with those most harmed by inequities—has access to trees and the benefits they provide and where we keep our trees and forest healthy and thriving in the face of a changing climate. Part of this vision is achieving our goal of at least **30% canopy coverage that is equitably distributed across the city by 2037.** Achieving this vision will also mean building new partnerships, engaging residents in the care and planting of trees, investing in preservation and maintenance of our existing trees, strengthening our regulatory framework while at the same time encouraging housing production, and developing plans to address specific climate hazards.

THE CHALLENGES AHEAD

As we work toward this vision for Seattle's urban forest, our efforts are impacted by challenges facing our trees and the city. Our strategies must incorporate solutions to these challenges to achieve the City's urban forest goals.

- **Climate change** is making our summers hotter and drier, which further stresses trees and makes them susceptible to new pests and diseases.
- **Budget limitations** impact our capacity to maintain our forests, especially as climate change impacts increase maintenance needs and associated costs.
- Our mostly **second-growth urban forest is aging**, making these trees more susceptible to drought and pests.
- **Our city is growing**, and trees are being removed for housing, infrastructure, and development.
- **Competing uses** such as underground utilities, sidewalks, landscaping, views, and new or expanded building footprints impact our ability to plant and care for trees. These competing uses are more difficult to manage in our right of way and on private property, which constitute most of the land area in Seattle at 27% and 65%, respectively.

IMPACTS OF CLIMATE CHANGE ON SEATTLE'S TREES

The Pacific Northwest is projected to rapidly warm during the 21st century as a result of greenhouse gases emitted from human activities. The resulting change in our climate has major implications for our residents and our urban forest.

Summers in the Pacific Northwest are increasingly hotter and drier, which means that newly planted trees need more water over a longer season and for more years. A three-year establishment period—the time during which trees are cared for and watered until they can sustain themselves—was historically the best management practice for newly planted trees. With current and expected future conditions, that period is increasingly being extended to five years across our urban forestry programs.

Drought conditions, along with the age of many of our trees, are also making our forest more susceptible to pests and disease. Whereas healthy trees are better able to fight off or survive contact with pests and diseases, older trees stressed by climate impacts have more difficulty. This can lead to increased limb loss and greater risk of tree death from pests or disease. This is especially significant in our parks, where larger stands of these second-growth forests are losing trees at a faster rate than other parts of the city.

Projected Climate Changes in the Puget Sound Region

Temperature: The Puget Sound region warmed by 1.3°F between 1895 and 2014. Projected warming in the 21st century will be at least double—and potentially up to ten times—the amount of warming we have already experienced.[2]

Precipitation: By the 2080s, the wettest days are projected to increase by 22%, and heavy rainfall events will be more intense and more frequent.[2] Large year-to-year and decade-to-decade variations in precipitation are expected to continue. Projections of overall annual precipitation are uncertain, but summer precipitation is projected to decrease.[3]

Trees are also critical to our community's ability to combat and be resilient to climate change impacts because they can reduce urban heat island effects. They provide shade that cools homes and neighborhoods, especially during extreme heat events. Trees can also regulate atmospheric temperature through evapotranspiration as water evaporates from leaves and cools the air, and they help manage stormwater runoff (especially evergreen species), which can protect against climate change-fueled flooding.[4]

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[2] UW Climate Impacts Group. (November 2015). *State of Knowledge: Climate Change in Puget Sound.* https://cig.uw.edu/wp-content/uploads/sites/2/2021/12/ps-sok_cover_and_execsumm_2015.pdf.

[3] Frankson, R., Kunkel, K. E., Champion, S. M., Easterling, D. R., Stevens, L. E., Bumbaco, K., Sweet, W. (2022). *Washington State Climate Summary*. NOAA National Centers for Environmental Information. https://statesummaries.ncics.org/downloads/Washington-StateClimateSummary2022.pdf.

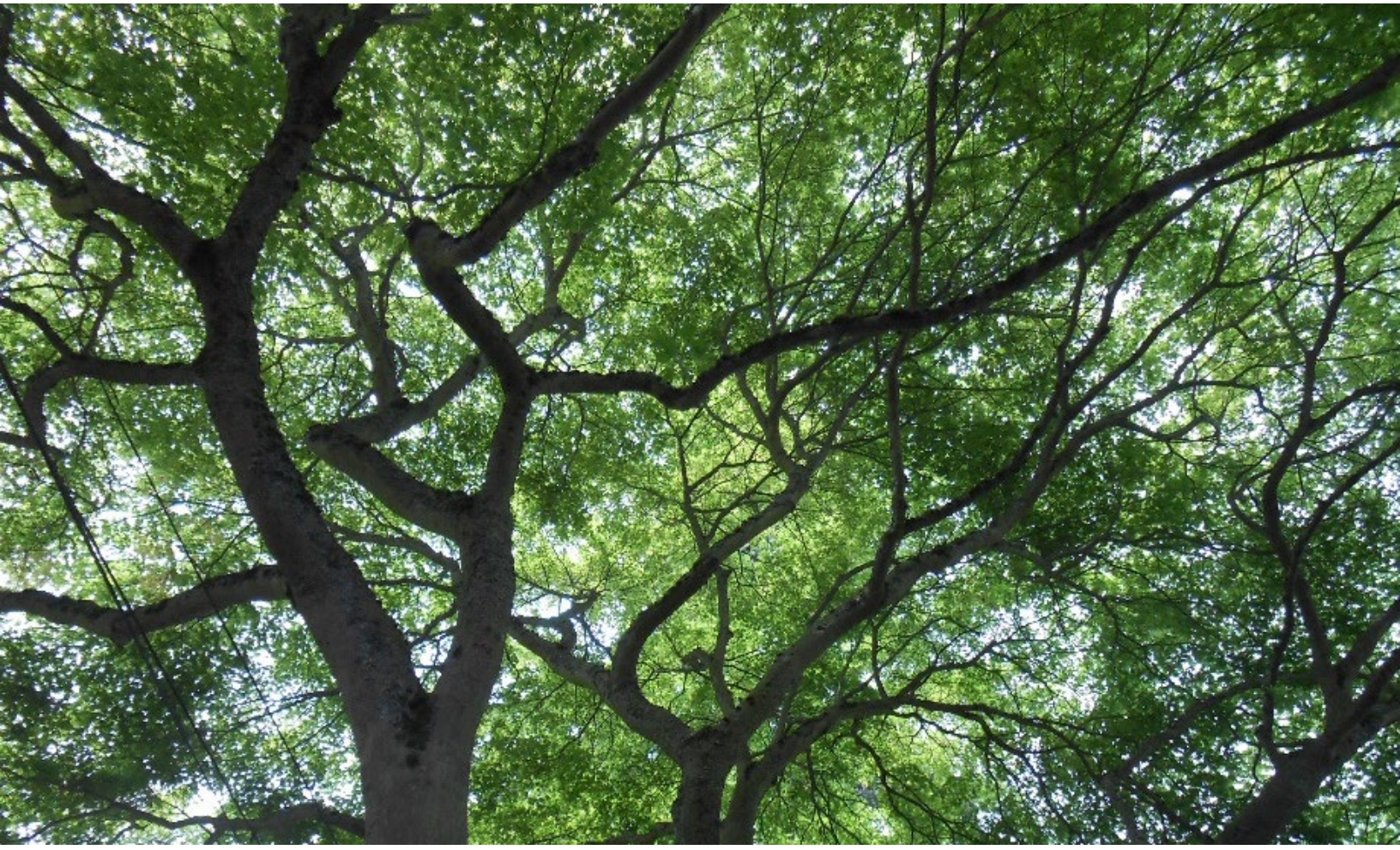
[4] Safford, H., Larry, E., McPherson, E. G., Nowak, D. J., & Westphal, L. M. (n.d.). *Urban Forests and Climate Change.* US Forest Service Climate Change Resource Center. https://www.fs.usda.gov/ccrc/topics/urban-forests.

MEASURING OUR PROGRESS

Forests, composed of living organisms, are constantly growing and changing. Urban forests are also impacted by forces within their urban setting. We measure our urban forest canopy cover every five years to understand and measure that change. We conducted a baseline canopy assessment in 2016, making this 2021 assessment our first opportunity to analyze trends that will help inform our urban forest management strategies.

This report describes the 2021 urban forest tree canopy as well as changes in canopy cover across Seattle since the baseline report in 2016. The findings show how change differed across different land use types, management units, neighborhoods, and other geographic units of the city. We also discuss the composition of our urban forests and the causes of both gains and losses in canopy cover.

Findings from this assessment will inform future planning efforts and development of strategies to achieve our vision.



ASSESSMENT METHODOLOGY

OVERVIEW

A tree canopy assessment measures the layer of leaves, branches, and stems that cover an area when viewed from above. Canopy assessments conducted at several points in time using the same methodology allow us to see how trees in our city have grown—where trees have gotten bigger or smaller, and where they have been planted or removed. The process used for this assessment combines Light Detection and Ranging (LiDAR) data and aerial imagery to provide a detailed tree canopy map. The resulting map (see Figure 1) shows the amount of canopy, as well as the structure (the number, size and height of trees), and distribution (where the canopy is and isn't) of the canopy, which ultimately provides an accurate picture of how our urban forest is changing. Following best practices, we use the canopy assessment to look at change over a multi-year period (five years in this case).

PROCESS

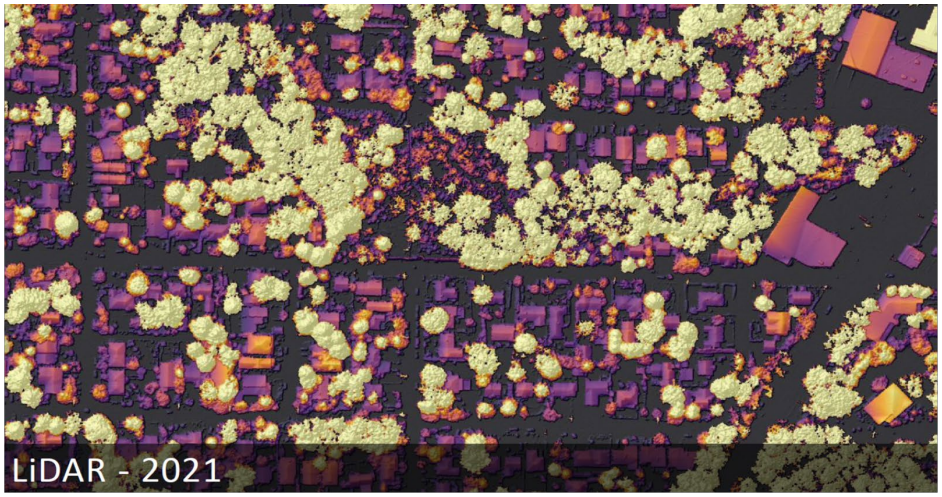
A team from the University of Vermont's Spatial Analysis Lab (SAL) measured the change in Seattle's tree canopy from 2016—2021 by combining high-resolution aerial imagery with LiDAR data, along with geographic information systems (GIS) layers from various governmental agencies in the region.[5]

Aerial imagery provides spectral (color) information that allows trees to be distinguished from objects such as buildings and roads. Since trees and shrubs can appear spectrally similar or be obscured by shadow, using LiDAR data enhances the accuracy of tree mapping, providing more granular data including tree size, count, structure, and distribution.

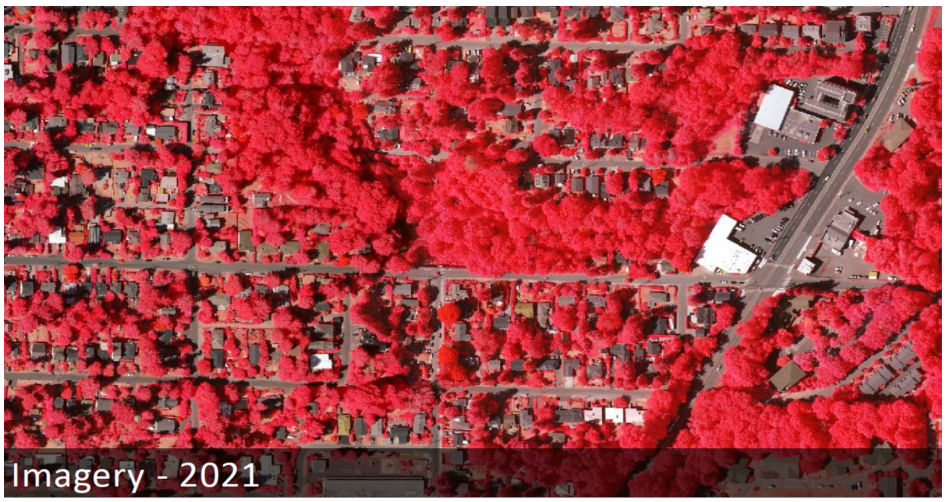
To map Seattle's tree canopy, the SAL team used a scientifically rigorous process, including the US Forest Service's Urban Tree Canopy (UTC) assessment protocols, to integrate cutting-edge, automated feature extraction technologies with detailed manual reviews and editing. This combination of sensor and mapping technologies resulted in a highly detailed map of tree canopy in Seattle. We then used the team's data and findings to analyze trends and their implications for Seattle's urban forestry management.

[5] The source data used for mapping came from the City of Seattle, King County, the State of Washington, and the USDA.

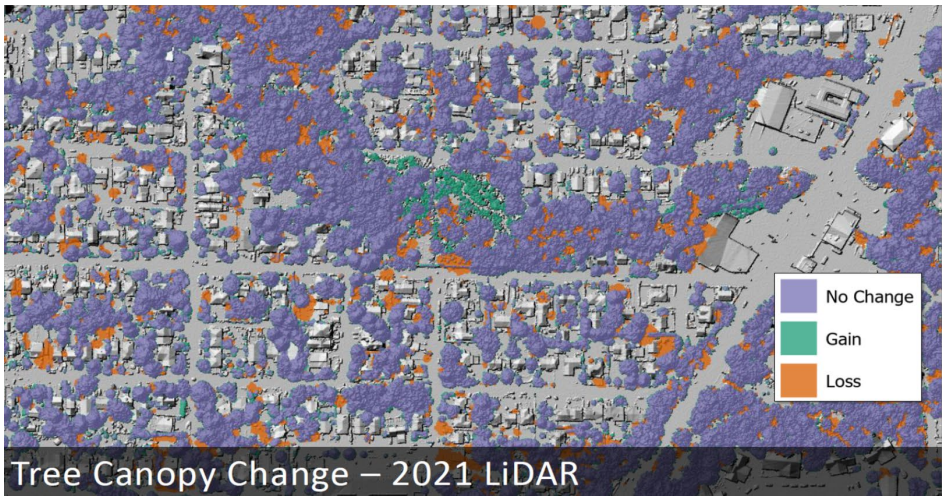
Figure 1. LiDAR data combined with aerial imagery create a detailed map of tree canopy gains and losses



LiDAR, a remote sensing technology, uses beams of pulsed light sent down from aircraft to the ground surface below to create a three-dimensional model of the earth's surface.



Aerial imagery provides spectral (color) information that allows trees to be distinguished from objects such as buildings and roads, when combined with the LiDAR data.



By combining LiDAR data and aerial imagery, we are able to map tree canopy and other land cover features. And by looking at this data in two time periods—2016 and 2021—we are able to see areas of change. In this image, the orange areas show where canopy has been lost, and the green areas show where canopy has been gained.

MEASURING GAINS AND LOSSES

With this resulting highly detailed canopy map, we can see where canopy was lost and where it grew, allowing us to measure the **change in canopy cover** both in absolute and relative terms.

Absolute tree canopy change is the difference in canopy cover between two time periods (new measurement minus original measurement). In this assessment, we measure the absolute change both as a number (acres) and as a percentage (canopy cover). Absolute change answers the question "how many acres were lost or gained between 2016 and 2021?" or "how many percentage points of canopy cover were lost or gained between 2016 and 2021?"

Absolute change in acres = 2021 canopy area in acres − 2016 canopy area in acres

Absolute percent change = Percent of city covered by canopy (percent canopy cover) in 2021 − percent canopy cover in 2016

Relative tree canopy change describes the magnitude of a change, using a reference value to give a sense of scale. In this case, the canopy cover in 2016 is used as a reference point, giving a sense of scale to the change between time periods. Relative tree canopy change, also referred to in this report as "relative precent change," answers the question "what is the magnitude of change between 2016 and 2021?"

$$\textbf{Relative change} = \frac{\text{Absolute change in acres}}{\text{Acres in 2016}}$$

Net Change = Gains - Losses

A deeper look at the absolute change reveals that behind that change, we see both growth (gains) and losses in the urban forest between the two time periods. Even during a time of net canopy loss, we have gained canopy in some areas. An overall net loss indicates that more canopy has been lost than gained.

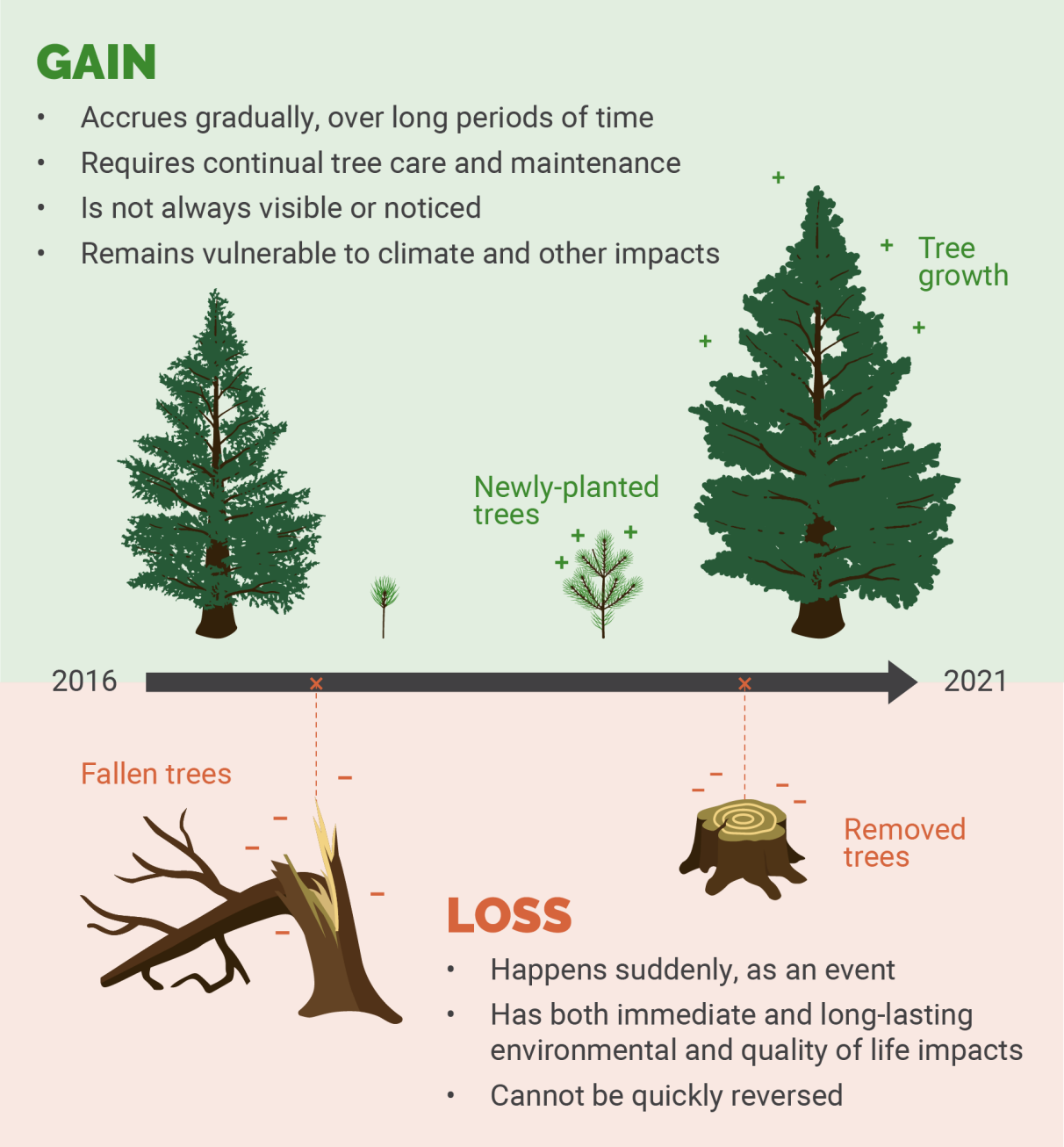
Net change represents the sum of gains and losses in acres of canopy cover expressed as one number. Net change equals the absolute change in acres. Throughout this report, "net change" is used when describing the gains and losses that underly that change.

Net Change = Absolute change in acres = Acres gained − Acres lost

Losses are evident and easy to picture—trees removed due to age, disease, or to make space for a different use. Canopy gains often go unnoticed. While we often think of new plantings, most canopy gain occurs over time as existing trees add branches and leaves through normal growth.

Losses occur quickly and can erase gains that took years to achieve. While planting new trees is critical to increasing canopy cover and ensuring forest succession, protecting and preserving existing mature trees contributes more in the near-term to overall canopy growth and associated co-benefits, and is a key focus of the City's efforts.

Figure 2. Canopy gains and losses



FINDINGS

WE ARE SLOWLY LOSING GROUND

Findings

Seattle's tree canopy is slowly declining at a time when we need more canopy to mitigate the effects of climate change and build community health and resilience. Since 2016, the net change in tree canopy is a **loss of 255 acres**—an area the size of Green Lake—which represents an **absolute decrease of 0.5%** (from 28.6%[6] in 2016 to 28.1% in 2021) and a **relative decline of -1.7%.** The difference between these numbers is described below.[7]

Absolute percent change = Percent of canopy cover in 2021 − Percent of canopy cover in 2016

= 28.1% − 28.6%

= 0.5% decrease

$$\textbf{Relative percent change} = \frac{\text{Absolute change in acres}}{\text{Acres in 2016}}$$

$$\textbf{-1.7\%} = \frac{-255}{15{,}279}$$

[6] In the 2016 Canopy Cover Assessment, Seattle's tree canopy was reported as 28% canopy citywide. The land cover mapping performed for this 2021 canopy assessment was done at a finer resolution due to having higher quality aerial imagery and LiDAR data available. This resulted in an updated determination of the canopy present in 2016. This assessment shows that there was 28.6% canopy cover present in 2016 rather than 28%.

[7] Typically, an absolute change would be described as a value (i.e., acres) and relative change as a percent. Because our value of interest (canopy cover) and our associated goal (30%) are described as percentages, it is important to distinguish between the absolute change in canopy coverage (0.5%) and the relative change in canopy coverage (1.7%) between 2016 and 2021.

The net change in our canopy is the result of losses and gains relative to 2016's baseline of **15,279 acres**. The city has lost **1,790 acres** and gained **1,534 acres** (primarily from existing canopy growing fuller and larger), resulting in a total net loss of 255 acres. -

Absolute change in acres = 2021 acres – 2016 acres

– **255** = 15,024 – 15,279

Net Change = Acres gained – Acres lost

255 acres net canopy loss = 1,534 acres of canopy gained – 1,790 acres of canopy lost

Interpretation

While the assessment methodology cannot explain why canopy was gained or lost in any given area, we know some common reasons for canopy gain and loss based on the experience and expertise of City urban forestry staff. Throughout this report, we share data and findings from the tree canopy assessment conducted by the UVM Spatial Analysis Lab as well as our interpretation of the findings. We also use these findings and our interpretation to inform recommendations for preserving and expanding our urban forest.

How do we gain canopy?

Most canopy gain occurs over time as existing trees successfully establish and mature over time, increasing their crown density and spread. **Protecting and caring for mature trees** allows them to continue growing and adding to our canopy. **Planting new trees and stewarding them through their establishment period and beyond** also contributes to a growing canopy. Programs like Trees for Neighborhoods have helped Seattle residents plant over 12,300 trees in their yards and in the right of way since 2009, and City departments planted nearly 10,000 trees between 2016 and 2021.[8] While not all of these trees survive to maturity, that's a potential 22,000 more trees working to clean our air and water, cool sidewalks and homes, and make our neighborhoods healthier. The recommendations in this report are designed to protect and steward our existing canopy and increase the survival rate of newly planted trees.

[8] Departments included in this reporting include Seattle Parks & Recreation, Seattle Department of Transportation, Finance and Administrative Services, Seattle Center, Seattle Public Utilities, Seattle City Light, and the Woodland Park Zoo, which, while not a City department, operates on City-owned land. Trees involved in this reporting are at least 2-inch caliper trees. The Green Seattle Partnership also plants thousands of tree seedlings each year in forested parklands—between 2017 and 2021, almost 125,000 tree seedlings were planted through this program.

How do we lose canopy?

Based on the experiences and expertise of urban forestry professionals, the primary reasons for canopy loss in Seattle include:

Climate change impacts. Our changing climate is making Seattle's summers hotter and drier, adding stress to our trees and making it harder for them to survive, especially in the early phases of establishment. By the 2050s, the average year in the Puget Sound region is projected to be 4.2°F warmer under a low greenhouse gas scenario and 5.5°F warmer under a high greenhouse gas scenario.[9] **Stress from heat and drought** make it harder for trees to survive contact with pests and diseases, which are also changing and increasing as climate conditions shift. Weakened trees are also more susceptible to damage during storms. Pests, diseases, and storm events can all create hazardous tree conditions which can necessitate removal.

Aging deciduous trees. While Seattle's native forest was predominantly made up of evergreen species, the composition shifted after the forest was clearcut beginning in the 1850s and native trees were replaced primarily with deciduous trees and non-native species. Much of our current urban forest is made up of aging second-growth, deciduous trees **nearing the end of their lifespans**, making them more susceptible to drought and pests as they face climate impacts.

Competing uses for limited space. Trees are also removed to make space for competing uses; for example, **infrastructure projects** to improve transportation and utilities sometimes involve tree removal or impact tree roots during construction that necessitates removal after construction. As our population grows, so does our need for additional **housing.** Although the City employs a suite of tools to preserve trees on private lands, new development can often result in tree removal. Residents may also remove trees to **make space for other uses** like landscaping or views.

Why it matters

The 255 acres of lost canopy would have provided a wide range of ecosystem benefits that are critical to Seattle's environment and its residents. The additional canopy would have stored hundreds of thousands of pounds of carbon, helped avoid millions of gallons of stormwater runoff, shaded hundreds of acres, kept millions of gallons of water from evaporating, and trapped thousands of pounds of pollutants. This lost canopy would have helped keep temperatures cool and clean the air and water across our city.

[9] UW Climate Impacts Group. (November 2015). *State of Knowledge: Climate Change in Puget Sound.* https://cig.uw.edu/wp-content/uploads/sites/2/2021/12/ps-sok_cover_and_execsumm_2015.pdf.

CANOPY LOSS IS NOT HAPPENING EQUITABLY

Context

Seattle, like most cities in the United States, is characterized by historic and ongoing racial and economic inequities such as lack of investment, redlining, lack of access to employment opportunities, and education, and wealth disparities. These systemic barriers have led to stark differences in where Black, Indigenous, and People of Color (BIPOC) residents reside, with a higher proportion living near industrial areas or transportation corridors where they experience higher neighborhood temperatures, poorer air quality, water pollution, and significantly less tree canopy cover.

For example, Black people are 75% more likely than White people to live in areas near commercial facilities that produce noise, odor, traffic, or emissions that directly affect the population.[10]

Guided by environmental justice principles and the Race and Social Justice Initiative, Seattle's urban forestry work advances healthy, resilient communities by prioritizing those currently and historically most harmed by racial, economic, and environmental injustices. We will use data from this assessment to support decision-making and focus investment in tree maintenance and planting in communities harmed first and worst by environmental and racial inequities, as well as investment in the capacity for communities to engage in tree planting, maintenance, engagement, decision-making, and advocacy in their own neighborhoods.

Defining Environmental Justice (EJ) Priority Areas

To identify EJ priority areas, we used the Seattle Office of Planning and Community Development's Racial and Social Equity Composite (RSE) Index, which includes data on race, language, origin, socioeconomic disadvantage, and health disadvantage.

This RSE Index divides census tracts into five categories based on their level of disadvantage. For the purposes of this assessment, we refer to the two most disadvantaged categories as **"environmental justice (EJ) priority areas."** In some cases, these were compared with the two least disadvantaged categories of the RSE Index. We refer to these as "**the most advantaged areas.**"

Methods

To analyze the relationship between environmental justice (EJ) priority areas and canopy cover, the SAL team overlaid a map of the EJ priority areas (the two highest

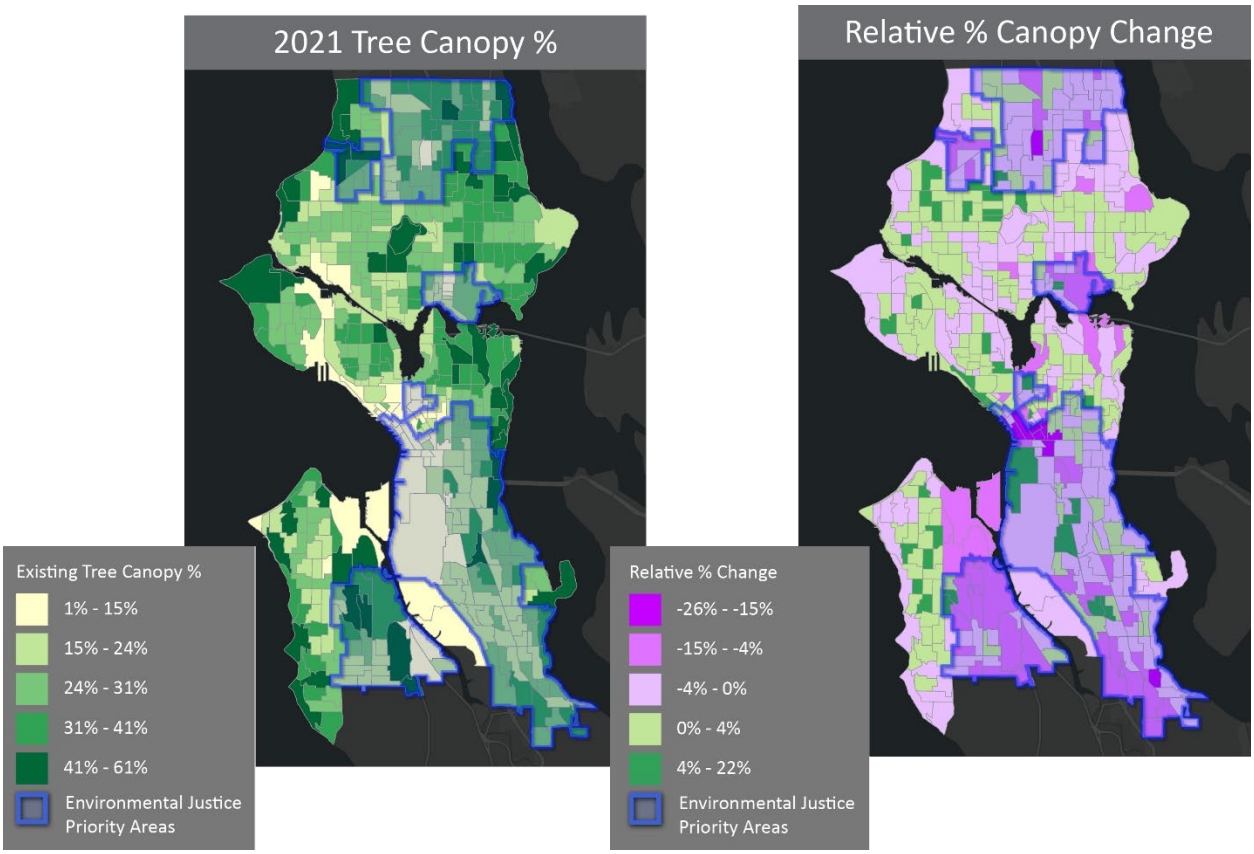
[10] Son, J., Patnaik, A., Feng, A., & Ade, C. (August 2020). *Racial Disparities and Climate Change*. Princeton Student Climate Initiative. https://psci.princeton.edu/tips/2020/8/15/racial-disparities-and-climate-change.

categories of RSE Index disadvantage)[11] with both the percent canopy cover and relative change in canopy cover maps.

The maps below illustrate the disparity in tree canopy cover across Seattle.

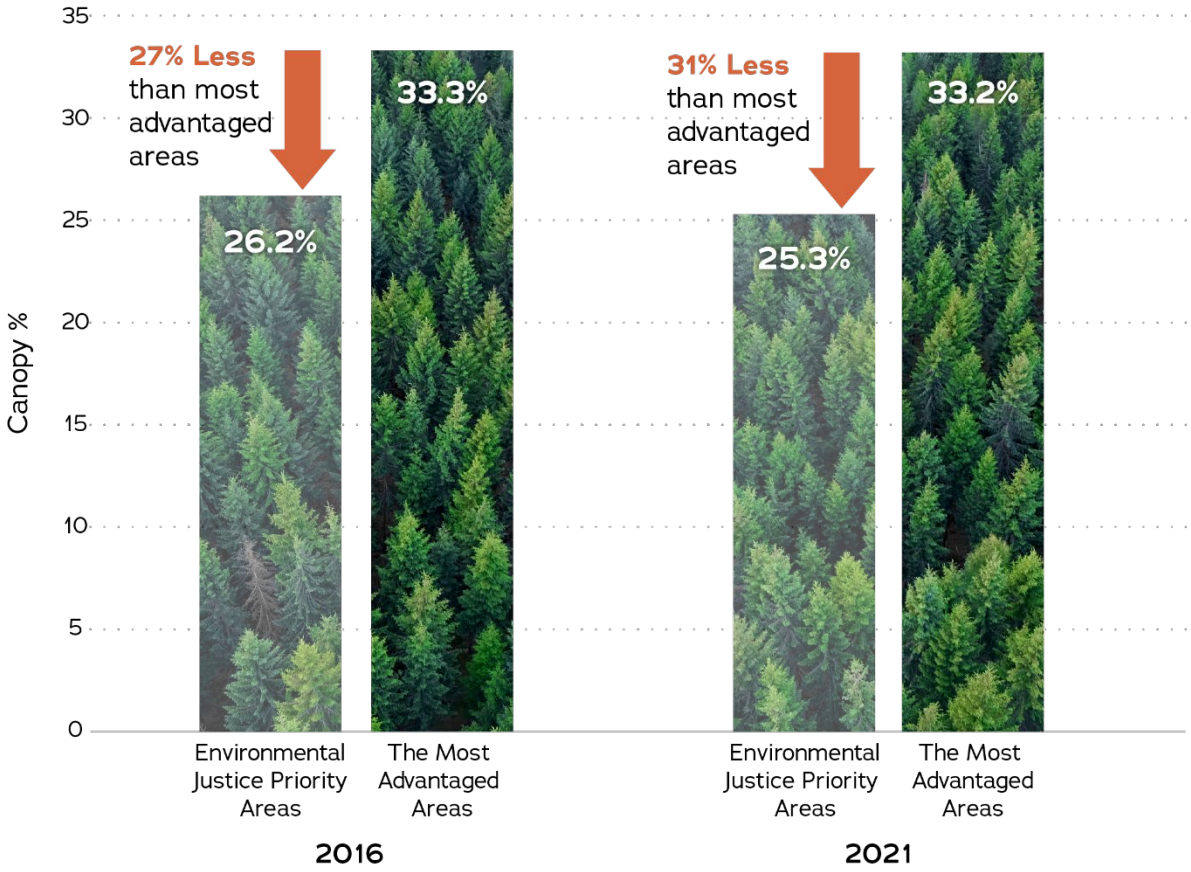
Findings

Figure 3. Tree canopy cover map and canopy cover change map overlaid with EJ priority areas



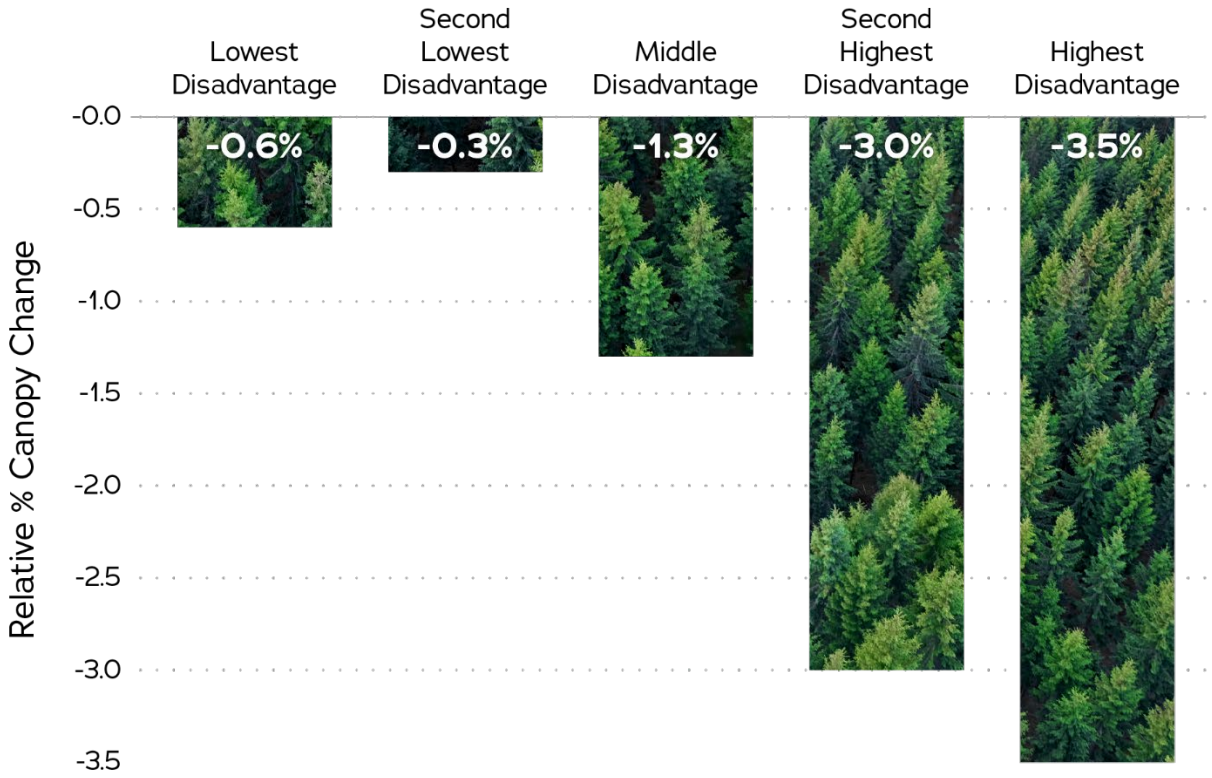
[11] This analysis was based on the 2019 RSE Composite Index. As of February 2023 (after the completion of the analyses included in this assessment), the Seattle Office of Planning and Community Development has released an updated RSE Index, which does not align with the data included in this report.

Figure 4. 2016 and 2021 tree canopy in RSE Index categories



In 2016, **EJ priority areas had 27% less canopy** than the most advantaged areas (26% vs. 33% canopy coverage). Over the period of the assessment, EJ priority areas experienced far more canopy loss than higher advantaged areas. By 2021, **EJ priority areas had 31% less canopy** than advantaged neighborhoods (25% vs 33% canopy coverage).

Figure 5. Relative percent canopy change from 2016-2021 by RSE Index category



This means that these EJ priority areas are experiencing disproportionately fewer benefits from our urban forest, including air and water pollution removal, heat island mitigation, and the other positive contributions to quality of life that trees provide.

Interpretation

These findings are consistent with other environmental equity data that indicate that through a history of settler colonialism, redlining, and lack of investment, neighborhoods impacted by racial and economic injustice have greater exposures to environmental burdens and experience fewer environmental benefits compared to neighborhoods with more socioeconomic advantages.[12] These maps and summary data show similar impacts related to tree canopy and provide a starting point for a deeper equity assessment of Seattle's tree canopy. Until further assessment is conducted, we can take away high-level findings (as above) and begin to identify specific neighborhoods for further analysis.

For example, a comparison of these maps shows that there were some canopy gains in some EJ priority neighborhoods, such as those including portions of the East Duwamish Greenbelt, Cheasty greenspace, and Longfellow Creek greenspace. These are areas

[12] Osaki, C., & Finkbonner, J. (June 2001). *Final Report State Board of Health Priority: Environmental Justice*. Committee on Environmental Justice of the Washington State Board of Health. https://www.digitalarchives.wa.gov/do/F093B7854B3FFB31174507C2F873DC56.pdf

where the City's forest restoration program Green Seattle Partnership (GSP) has been implementing tree planting and restoration efforts, leading to increases in canopy.

However, the same comparison shows more areas experienced losses than saw gains. These include areas such as the Northgate Link light rail project area, where trees were removed to accommodate a public transportation asset, and portions of the West Duwamish Greenbelt. Parts of Rainier Valley also saw high rates of loss.

We will analyze the data behind the maps in greater detail to better understand trends and needs in each area as we develop our plan for future equity-driven investments to reverse this trend. This analysis can also help us understand why we are seeing a greater rate of losses in these areas, where the City's urban forestry programs are making a positive impact in priority neighborhoods, and how to accelerate any gains being made.

CLIMATE CHANGE IS MAKING OUR TREES MORE ESSENTIAL, AND HARMING THEM

Context

Climate change impacts have been observed around the globe, across the United States, and here in the Pacific Northwest. Climate change is expected to increase the number of extreme heat events and the chance of both droughts and floods, along with an increase in wildfires and dangerous smoke events. Heat events are likely to increase hospitalizations, deaths, and demand for emergency medical services. More frequent wildfires will worsen air quality and increase hospitalizations related to respiratory conditions. [13]

Figure 6. Smoke from summer wildfires obscuring the Space Needle

Climate change will impact all Seattle residents, but communities of color will bear a disproportionate burden. Specifically, our hotter summers mean that neighborhoods with less tree canopy will suffer higher temperatures during these heat events. Increasing canopy in these neighborhoods will increase their resiliency and is an important part of the City's long-term climate preparedness and resilience plans.

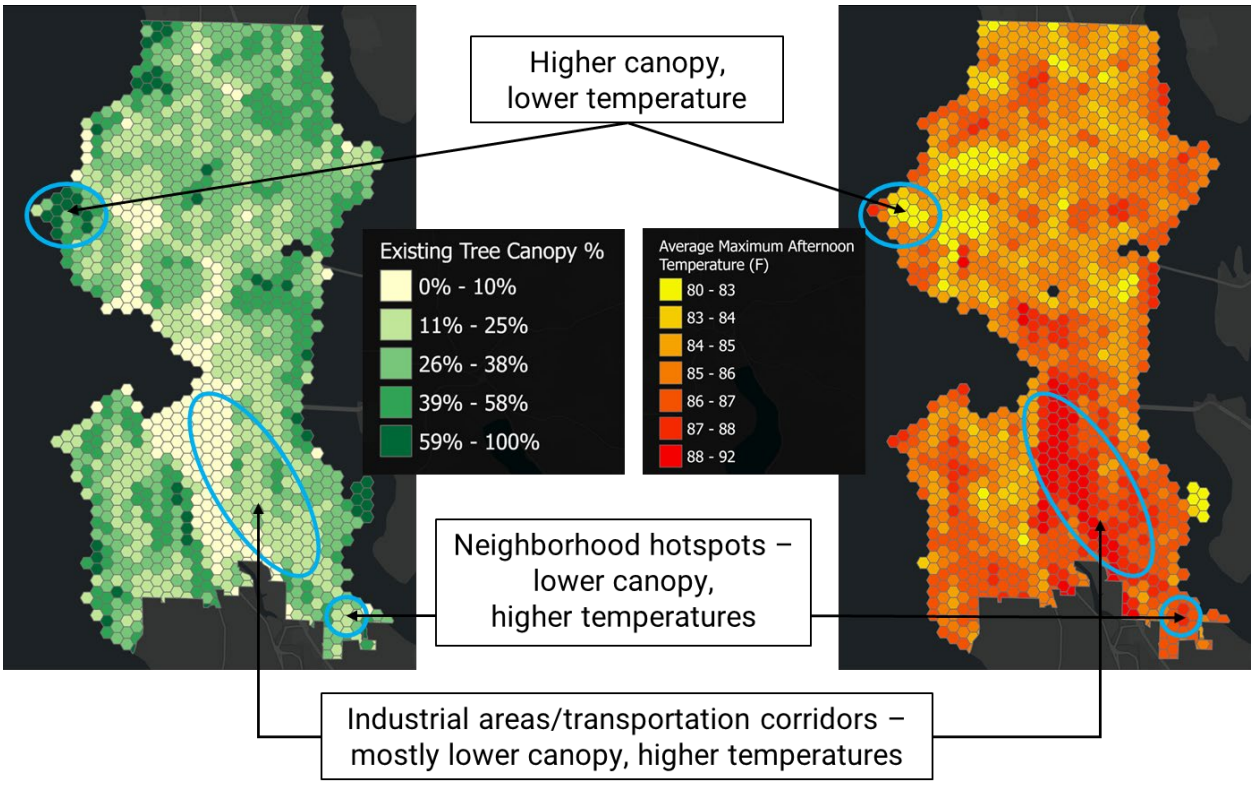
Methods

To study the relationship between tree canopy and heat, the SAL team used a hexagon scale—where hexagons are the size of several city blocks— to map both canopy cover and average afternoon temperatures across the city using heat data from the King County Heat Watch Report conducted in 2020.[14] This heat study measured temperature at various times of day using car-mounted thermometers driving preset routes throughout the region. Collecting coordinated data over several periods on a hot summer day provided snapshots in time illustrating how heat varies across

[13] UW Climate Impacts Group. (February 2019). *No Time to Waste: The Intergovernmental Panel on Climate Change's Special Report on Global Warming of 1.5°C and Implications for Washington State*. https://cig.uw.edu/wp-content/uploads/sites/2/2019/02/NoTimeToWaste_CIG_Feb2019.pdf.
[14] CAPA Strategies, LLC. (2020). *Seattle & King County Heat Watch Report*. https://your.kingcounty.gov/dnrp/climate/documents/2021-summary-report-heat-watch-seattle-king-county.pdf.

neighborhoods and how local landscape features impact temperature and humidity. These maps are shown in Figure 7 below.

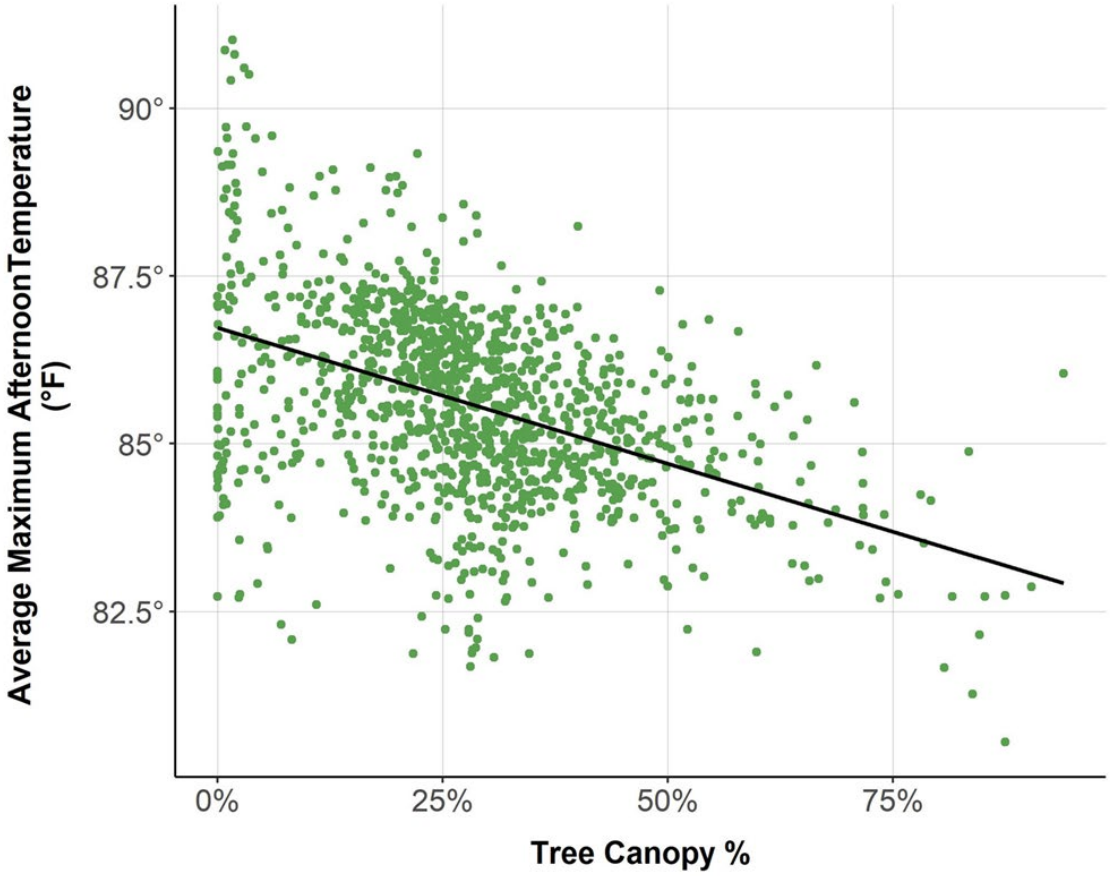
Figure 7. Comparison of canopy cover and heat maps



Findings

The SAL team analyzed tree canopy data in relation to the heat data. The scatter plot in Figure 8 shows the relationship between maximum afternoon temperatures in the 2020 heat study and percent tree canopy based on the 2021 canopy data. The team found that, at the hexagon scale on a hot day (where a hexagon is the size of several city blocks), hexagons with **26% tree canopy experienced temperatures that were 1-degree lower than hexagons with no canopy.**

Figure 8. Scatter plot showing the relationship between maximum afternoon temperature and percent tree canopy



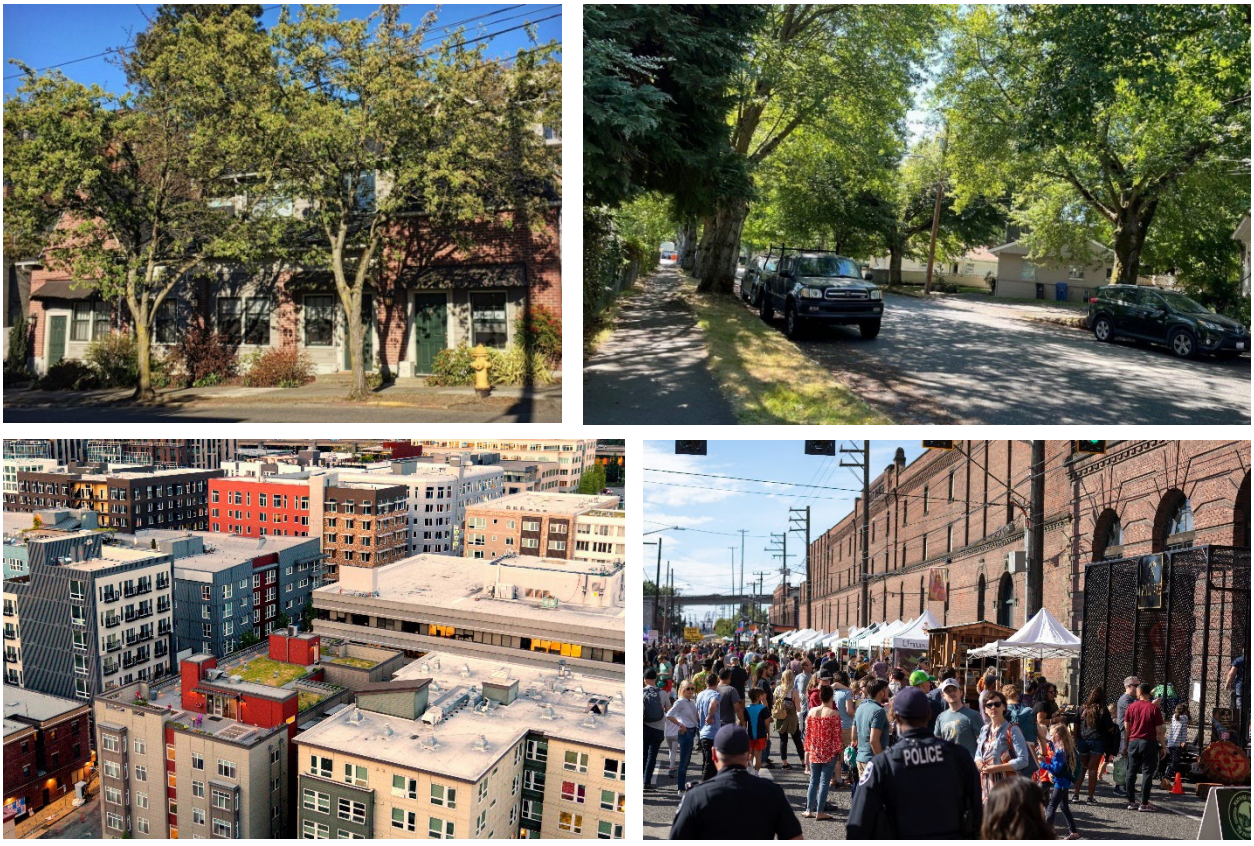
Interpretation

Extreme heat is a serious health threat to communities, and climate change is expected to bring more heat waves and hotter temperatures. This means that growing canopy coverage in low-canopy neighborhoods is a critical aspect of our long-term heat preparedness strategy.

In addition to the analysis of canopy in our EJ priority areas described above, comparing canopy cover and heat maps helps further refine our target areas as we prioritize urban forestry efforts in the city.

Similar to comparing the canopy cover and canopy change maps of our EJ priority areas to identify target areas for increasing canopy, we can also compare canopy cover and heat maps to identify and refine focus areas. Figure 7 illustrates canopy and heat relationships in various parts of the city. There are larger areas of low canopy and warmer temperatures, like the heat islands in and around industrial areas and major transportation corridors. There are also smaller areas where neighborhoods with low canopy experience higher temperatures, such as neighborhoods in the Chinatown-International District and in the south end of Rainier Valley. The photos in Figure 9 show a comparison of the shade provided in neighborhoods with trees and neighborhoods without.

Figure 9. Homes in neighborhoods with shading trees compared to neighborhoods without



MANAGEMENT UNIT ANALYSIS

CONTEXT

All of Seattle's trees can be grouped based on ownership and management. There are three categories of ownership: public, private, and street trees; and nine management units.

Tree Ownership

Public trees are those whose ownership and management falls exclusively to City government, including trees in parks and on other City-maintained property. Parks comprise 9% of the Seattle's land area.

Private trees are those found on private property. Private trees are located in residential neighborhoods, in commercial and industrial areas, and on campuses or other major institutions. City government plays an important regulatory and supporting role for these trees. Combined, these areas make up 64% of the city's land area.

Street trees are those found in the public right of way, carved out along major streets, sidewalks, and other corridors used by all. In most cases, street trees are the maintenance responsibility of the adjacent property owner. In all cases, maintenance, planting, removal, and replacement requires a permit from the Seattle Department of Transportation (SDOT). The public right of way makes up 27% of the city's land area.

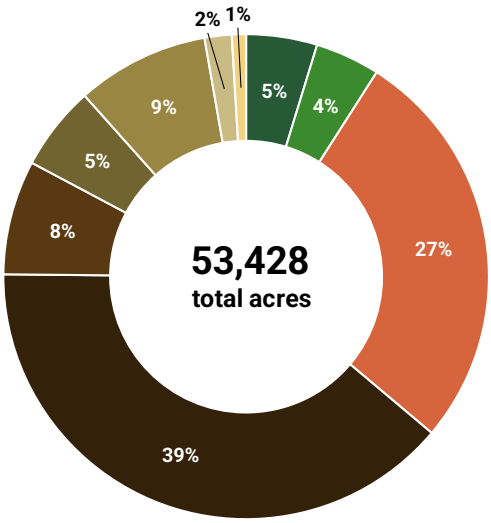
Urban Forestry Management Units

To effectively manage Seattle's urban forest, we further categorize trees and land into **urban forestry management units (MUs)**. These nine distinct MUs are based on physical characteristics, management responsibility, and geographic location within the city.

MU categories are defined specifically from an urban forestry perspective. The 2020 Urban Forest Management Plan includes more detail about the different considerations for urban forestry management across the MUs. The amount of the city's land covered by each MU is shown in Figure 10.

In the following sections, we describe findings from the canopy assessment by MUs and their implications, with a focus on larger MUs (Neighborhood Residential, Right of Way) and those that comprise a large percentage of the city's canopy (Parks Natural Areas).

Figure 10. City land area by management unit



	Management Unit	Total Land Area (acres)
Public	Parks Natural Areas	2,526
Public	Developed Parks	2,305
Public	Right of Way	14,482
Private	Neighborhood Residential	20,841
Private	Multifamily	4,074
Private	Commercial / Mixed Use	3,010
Private	Manufacturing / Industrial	4,722
Private	Major Institutions	963
Private	Downtown	505

How Do Different Management Units Contribute to the City's Canopy?

The three MUs that comprise most of the city's tree canopy are **Neighborhood Residential, Right of Way, and Parks Natural Areas**. Combined, these MUs make up **84%** of the city's canopy cover.

- **Neighborhood Residential** makes up **39%** of the city's land—the single largest MU by size. With roughly one third of that land area covered by canopy, it contributes nearly half of all the city's canopy (47%).
- **Right of Way** makes up **27%** of the city's land area and contributes nearly one quarter of the city's canopy (23%). Right of Way includes areas such streets, sidewalks, planting strips, and alleys. While Right of Way runs through all other MUs, it is separated in this assessment into its own MU.[15]
- **Parks Natural Areas** makes up only 5% of the city's land, but due to its concentrated canopy (82% canopy cover), it contributes 14% to the city's total canopy cover. Despite its small land area, Parks Natural Areas is the third largest contributor to the city's canopy, encompassing the forested areas and trails within Seattle's parks.

The remaining MUs, while each contributing a small share to the city's overall canopy, still play an important role. For example, though the Downtown MU makes up only 1% of the city's land area and less than 1% of the city's canopy cover, trees downtown are an important part of the urban experience, buffering the hardscape of buildings, streets,

[15] The MU analysis in the 2016 Seattle Tree Canopy Assessment included Right of Way as part of the land area of the adjacent MU. In this analysis, Right of Way was calculated as a separate MU both for 2021 and 2016.

and sidewalks with natural life, offering peaceful places to sit, and providing shade on hot days. Developed Parks also play an important role in the canopy, especially in neighborhoods with less space available for tree cover in the Right of Way or on private land. Developed Parks have high canopy coverage (30%) given their many uses, which also include playgrounds and playfields, and park acquisition is one potential method to address neighborhood-based canopy gaps.

Table 1 details the area of the city covered by each MU, the canopy cover of each MU, and the percent contribution of each MU to the city's canopy.

Table 1. Land area, canopy coverage, and contribution to city's canopy by management unit

	Management Unit	Land Area (% of City)	2021 Canopy Cover	% Contribution to City's Canopy Cover in 2021
Private	Neighborhood Residential	39%	34%	47%
	Multifamily	8%	23%	6%
	Commercial/Mixed Use	5%	12%	2%
	Downtown	1%	5%	<1%
	Manufacturing/Industrial	9%	4%	1%
	Major Institutions	2%	24%	2%
Public	Developed Parks	4%	30%	5%
	Parks Natural Areas	5%	82%	14%
	Right of Way	27%	24%	23%
	City Total	**100%**	**28%**[16]	**100%**

METHODS

The land cover maps the SAL team created for 2016 and 2021 served as the basis for the tree canopy analysis. Tree canopy data were derived from these land cover maps and summarized by each of Seattle's MUs to determine how tree canopy cover changed across MUs between 2016 and 2021.Tree canopy was calculated both in terms of total area and as a percentage of the land area within each MU. Change metrics were calculated based on a comparison with 2016 data, using the same MU categories.

[16] 28% is the citywide canopy cover, not the average across management units.

KEY FINDINGS

All Management Units Lost Canopy

Every management unit saw an overall net canopy loss since 2016. Though each MU gained tree canopy in some places, these gains were outweighed by greater losses.

Tree Canopy Loss Happened Across Public, Private, and Street Trees

Tree canopy loss happened across all ownership groups, but predominantly in the public and private groups. Public trees saw a net loss of 117 acres since 2016, representing 46% of the net loss citywide. Private trees saw a net loss of 105 acres since 2016, representing 41% of the net loss citywide.

Figure 11 below shows the canopy in each MU and how the canopy changed between 2016 and 2021. The graph also shows the gains, losses, net acreage change, and relative percent change in each MU during the assessment period.

Losses Were Greatest in Parks Natural Areas and Neighborhood Residential

The highest net losses were in **Parks Natural Areas** (111 acres, or 5.1% relative loss) and **Neighborhood Residential** (87 acres, or 1.2% relative loss). Parks Natural Areas make up a small area of the City's land but are a large contributor to the city's canopy. Neighborhood Residential makes up the largest share of the city's land and is a large contributor to the city's canopy. **These two areas combined made up 78% of the canopy lost since 2016.**

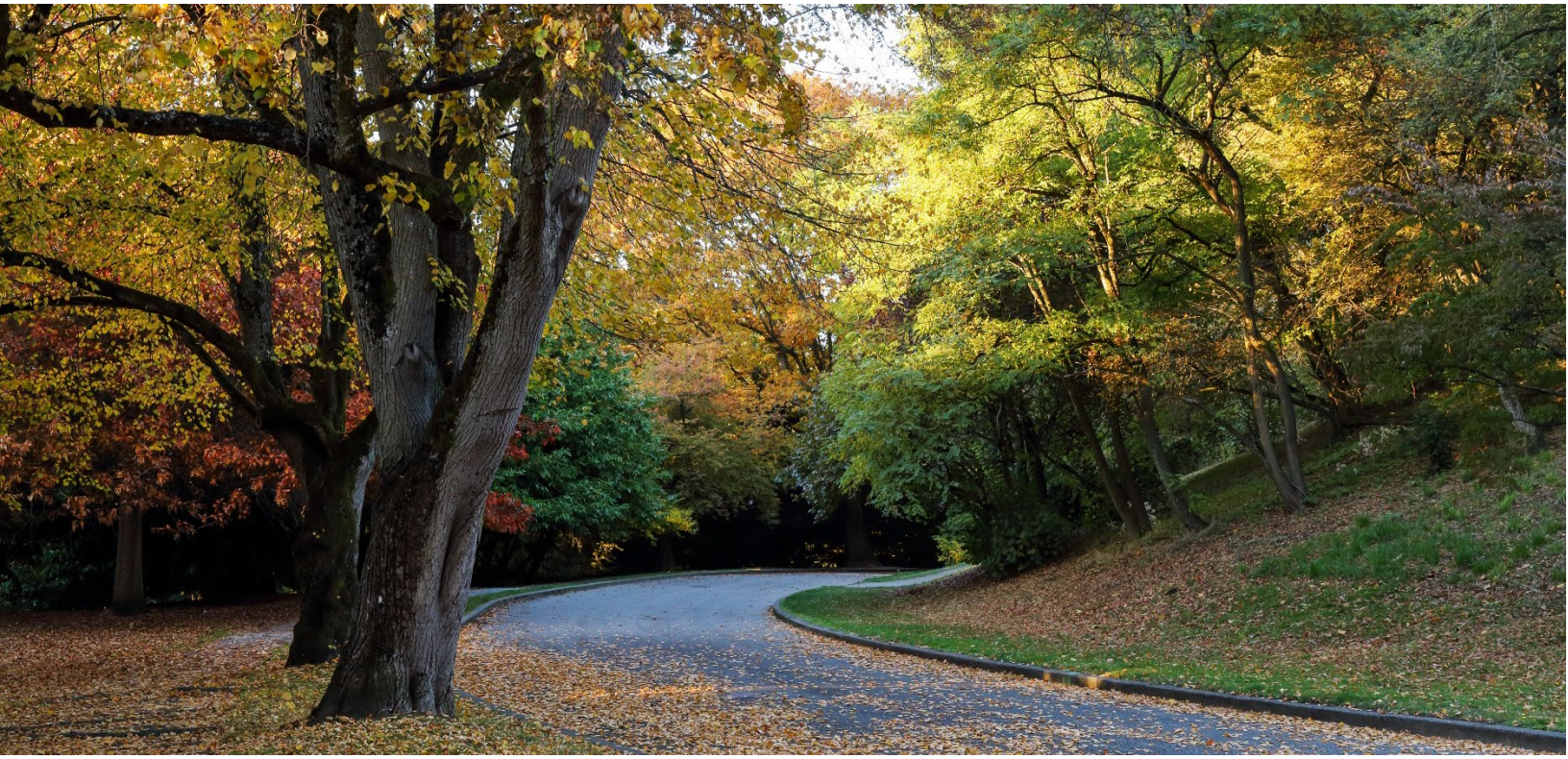


Figure 11. Tree canopy change between 2016 and 2021 by management unit[17]

Figure 11 describes relative and absolute tree canopy change between 2016 and 2021 by management unit, and the contribution of gains and losses to the absolute change in each MU. A table with this data is available in Appendix A: Canopy Losses and Gains by Management Unit.

As shown in Table 1, **Neighborhood Residential** contributes more to the city's canopy than any other MU, with **47% of Seattle's tree canopy**. It also makes up the largest land area in the city (39%) and has relatively high canopy coverage (34%). For this reason, gains and losses in this area play an outsized role on the city's overall canopy. The **net loss of 87 acres** (1.2% relative loss) made up over a third of the city's overall canopy loss during the assessment period.

The **Right of Way** also comprises a large portion of the city's canopy (23%) and 27% of the city's land area. Canopy coverage for this MU—which includes the city's roads, sidewalks, planting strips, and medians—is 24%. As shown in Figure 11, canopy gains

[17] Due to rounding, some totals may not correspond with the sum of the separate numbers.

and losses roughly balanced out, with a **net loss of 10 acres** (0.3% relative loss) in this MU.

The **Parks Natural Areas** MU makes up a small portion of the city's land (5%), but due to its high canopy coverage (82%), it is a major contributor to the city's canopy (14%). Losses during the assessment period outpaced gains, which were lower in this MU than in other MUs and are discussed in more detail in the following section. Overall, this MU had a **net loss of 111 acres** (5.1% relative loss)—nearly half of the city's overall canopy loss**.**

While the **Multifamily** MU is a smaller area of the city than its residential counterpart, it had a **net loss of 18 acres** (1.9% relative loss). Neighborhood Residential and Multifamily MUs together had a **net loss of 105 acres** since 2016, representing **41% of the citywide loss**.

The remaining non-residential, privately owned MUs comprise a smaller area of the city (only 18%) and together had a **net loss of 22 acres**, representing **9% of citywide loss**. Some of these areas (e.g., Manufacturing/Industrial, Downtown) are anticipated to have lower canopy than other areas, due to their dominant land uses involving large areas of impervious surface, but to meet Seattle's canopy goals we strive for canopy gains in all areas.

HIGHLIGHTS BY MANAGEMENT UNIT AND OWNERSHIP GROUP

This section highlights the changes in MUs that comprise most of the city's tree canopy: Parks Natural Areas, Neighborhood Residential, and Right of Way. Each section describes context specific to that MU, associated assessment findings, and interpretation of those findings.

Parks Natural Areas

Context

+71 acre gain
-182 acre loss
-111 acre net change

Parks
Natural Areas

Parks Natural Areas occupy very little city land area (5%), but because they are so densely forested, they contain 14% of the city's canopy—the third highest after Neighborhood Residential and Right of Way. These natural areas—the forested sections of our public parks—provide substantial environmental benefits and require active management to ensure long-term forest health and resilience. Caring for these areas includes removing undesirable weeds, planting native species, and fostering conditions for establishment of the next generation of forest. Seattle's Parks Natural Areas benefit from the Green Seattle Partnership (GSP). Since 2005, GSP has been planting native and climate-resilient plants and ensuring establishment and maintenance of enrolled

restoration sites. GSP restoration activities have increased since the creation of the Seattle Park District in 2014 which significantly increased the program's funding.

Findings

According to the assessment, Parks Natural Areas saw a **net loss of 111 acres** (5.1% relative loss) since 2016. As shown in Figure 11, the relatively low gains in this MU are the major contributor to this net loss. Comparing data on absolute loss alone (see Appendix A: Canopy Losses and Gains by Management Unit), the amount of loss in Parks Natural Areas was comparable to or lower than loss in other MUs (8% loss of canopy compared to 12% in both Neighborhood Residential and Right of Way, and 14% in Multifamily). However, gains in Parks Natural Areas are significantly lower than in any other MU, resulting in a higher net loss (3% gain for Parks Natural Areas compared to 11% gain in Neighborhood Residential and 12% gain in Right of Way).

Total Land Area and Canopy Coverage are Key Factors in Areas with Greatest Change in Canopy

Though the **Neighborhood Residential** area's relative loss of **1.2%** of tree canopy may seem small, since this MU makes up such a large portion of Seattle's urban forest, that amounts to **more than a third of the 255 total acres lost** between 2016 and 2021. Similarly, the **Parks Natural Areas' 5.1% relative loss** in tree canopy amounts to 111 acres—**slightly less than half of Seattle's net canopy loss** even though Parks Natural Areas make up only 5% of the city's land area.

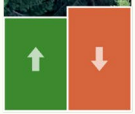
Interpretation

At least part of this low gain may be explained by tree growth patterns. In densely wooded areas like Parks Natural Areas with over 80% canopy cover, most canopy growth happens vertically as trees compete with their neighbors for light. Canopy cover—a two-dimensional measurement—does not capture multiple layers in the forest, so some gains in these areas may be obscured by layered canopy and therefore not show up in the assessment. In addition, while GSP has increased annual plantings in Parks Natural Areas in the last six years, these newly planted trees grow more slowly in early years, and while evergreens provide more ecosystem benefits, they grow more slowly than deciduous trees. The impacts of climate change on our forests are likely amplified in this MU due to the high percent of canopy cover here. The losses seen in this MU may also be due to aging deciduous trees coming down naturally or being selectively removed to allow for new evergreen growth. While these new plantings may not contribute substantially to canopy cover gains in the near-term, these plantings are nonetheless critical for the establishment of the next generation of our forests.

Neighborhood Residential Areas

Context

Neighborhood Residential makes up 39% of the city's land—the single largest MU by size. With roughly one third of that land area covered by canopy, it contributes nearly half of all the city's canopy (47%). Residents spend much of their time in these areas, and canopy in this MU provides many benefits: cooling during heat events, play and shade for children and families, and boosts to mental and physical health. Neighborhood Residential areas also include other land uses woven through them that provide benefits, such as medians and planting strips in the right of way and neighborhood parks. The canopy in these areas is considered in their separate MUs in this analysis, but as we consider holistic and equitable growth of the city's canopy, we will explore opportunities throughout these geographically interconnected MUs.



+783 acre gain
-870 acre loss
-87 acre net change

Neighborhood Residential

Findings

According to the assessment, Neighborhood Residential areas had a **net loss of 87 acres** (1.2% relative loss) since 2016. While the relative decline is below the citywide relative loss of 1.7%, the loss is consequential, as this lost canopy makes up **more than a third** of the total net acres lost citywide.

Interpretation

With a large existing canopy in this area, new branches and leaves growing on existing trees have helped to prevent larger canopy losses. The development analysis (see the following page and Appendix B: Tables of Development Parcel Data) provides important context for reviewing the data in the Neighborhood Residential MU. This analysis shows that a small percent of land in this MU underwent new development (the construction of new buildings) during the study period, but canopy losses were high on those properties where new development happened.

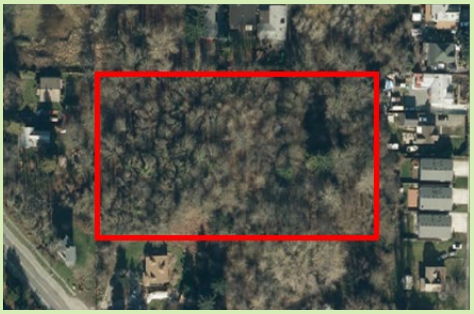
Based on that analysis, most trees in this MU were likely lost due to reasons other than development. Like other MUs, this may include disease or hazard risk, storm events, or aging trees at the end of their lifespan. Trees are also removed to accommodate other uses (e.g., solar arrays, views, gardens, etc.). Maintenance, public engagement, and a strong regulatory framework are critical for sustaining trees in this MU.

Impact of Development on Tree Canopy

To assess the impact of development (building) on tree canopy, the SAL team analyzed canopy changes on parcels that were redeveloped between 2017 and 2021[18] and compared them to parcels where no development projects were completed during this time. "Redeveloped parcels" were defined as sites that began and completed construction of new buildings that added residential units or new commercial buildings within the identified timeframe. The analysis included canopy gains, losses, and net change, and the absolute and relative percent changes in canopy between 2016 and 2021 on this group of parcels citywide and grouped by management unit. The management unit analysis is available in Appendix B: Tables of Development Parcel Data.

The results of this analysis show that:

- **Sites that were redeveloped represent a small percent of the city's land area**. For example, only 1.2% of land in the residential management unit was redeveloped during this time period—representing only 1% of the city's area overall.
- **Canopy loss was high on sites where redevelopment took place.** Citywide, the group of sites where construction projects were completed saw a relative canopy loss of 40%, compared to the 1.7% loss seen citywide.
- **Most canopy loss in residential areas was not associated with this redevelopment.** 70% of canopy loss in residential areas was unrelated to a redeveloped site.[19]



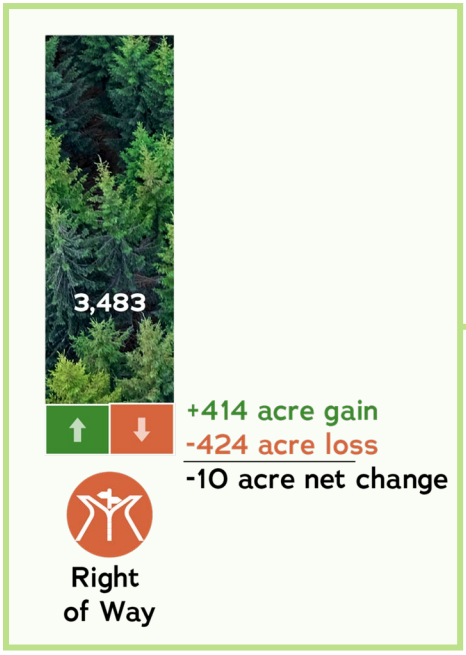
Citywide (All Management Units)	Redeveloped Parcels	Parcels Not Redeveloped	Total
Total land area in 2021 (acres)	511	52,915	53,427
Canopy present in these parcels – 2016 (acres)	88	15,190	15,279
Canopy present in these parcels – 2021 (acres)	53	14,970	15,024
Relative % change in canopy 2016-2021	-39.8%	-1.4%	-1.7%
Net change in canopy in these parcels 2016-2021 (acres)	-35	-220	-255
Parcels where new development occurred represent 1.0% of total area in the city.			
The 35 acres of net canopy loss in redeveloped parcels = 13.7% of the total acres lost in the city.			

[18] In this dataset, parcels that began and completed construction of new buildings that added residential units or new commercial buildings between 2017 and 2021 are included in the "Redeveloped Parcels" category. All other parcels are included in the "Parcels Not Redeveloped Category."

[19] See Appendix B: Tables of Development Parcel Data, for data specific to residential areas.

Right of Way

Context



The Right of Way runs through all the other MUs, comprising 27% of the city's land. The trees that line the streets and boulevards of many Seattle neighborhoods provide shade, habitat, and a sense of ambience. Most trees in the Right of Way (around 84%) are privately managed by the adjacent landowner, and the remaining street trees are managed by the City, either by SDOT or Seattle Parks and Recreation (SPR). Over the last seven years, SDOT has planted more than 2,700 trees in the Right of Way through investments made possible by the Move Seattle levy. These trees are providing shade, air quality, and quality of life improvements throughout Seattle, with a focus on communities with most harmed by environmental inequities. The Right of Way MU is a critical element of Seattle's tree canopy since it is owned and regulated by the City and runs through all MUs and geographic areas of the city. Stewardship and maintenance of existing street trees is critical given the challenges facing street tree growth and health, and the many competing uses for space in the right of way. Since most street trees are managed by the adjacent property owner, partnerships and engagement are critical for supporting street tree maintenance.

Findings

According to the assessment, the Right of Way MU is the second highest contributor to the city's canopy (23%) after Neighborhood Residential. Right of Way saw a **net loss of 10 acres** (0.3% relative loss), representing **4% of overall canopy loss** in the city (see Figure 11 and Table 1).

Interpretation

Trees in the Right of Way face the same stressors as trees elsewhere, while also facing specific challenges like being constrained by the limited space and soil volume that planting strips can provide. Frequent maintenance and care for existing trees is also essential. Soil quality can also be a challenge in some Right of Way areas, particularly in areas that have been used for parking or other activities that compact soil. As a publicly owned space, the Right of Way is ripe for opportunity. To continue growing canopy while sharing space with other uses, creative technologies like flexible pavement, soil cells, expanded tree pits, and appropriate soil types will be increasingly important. We must pursue creative approaches to maximize Right of Way for green infrastructure in appropriate locations, for example by replacing parking spots and curb bulbs to support park-scale street trees and installing planted bike lane and curb line buffer strips between curbs and sidewalks.

RECOMMENDATIONS

We are further away now than we were five years ago from our goal of 30% canopy coverage equitably distributed across the city, and if observed trends from this assessment continue, it may become impossible to meet that goal by 2037. To reverse this backward slide, our urban forest strategies must include innovative and equity-driven actions across a spectrum, including in planning, maintenance, planting, and engagement. As we prioritize activities and investments, we must also incorporate the demands of a changing climate and balance tradeoffs between conservation and development.

EXPAND UPON WHAT'S ALREADY WORKING

We are already investing in growing our tree canopy through multiple public-private partnerships and City interdepartmental initiatives and programs, but we can and need to do more. To make progress and grow our tree canopy cover, we must:

- **Increase funding to maintain and steward City-owned trees**. Preserving and maintaining our existing trees are the most efficient and effective ways to reverse our declining canopy and ensure future growth.
- **Develop a tree stewardship program** as an expansion of Trees for Neighborhoods to focus on care and maintenance of trees on residential property by supporting residents with landscape planning, basic tree care, planting and establishment, soil health, sustainable yard care, chemical use reduction, and more.

- **Increase stewardship and active management of forested parks** through the Green Seattle Partnership and increased partnerships with BIPOC and Indigenous communities for on-the-ground restoration and stewardship.
- **Expand partnership approaches to plant and maintain trees on private property, right of way, and public lands in low-canopy neighborhoods** by partnering with community-based groups, leveraging funding from multiple agencies, and meeting aligned goals for canopy growth, stormwater management, and air quality.
- **Plant more trees in the right of way and parks.** Get creative about using public space to plant trees, especially in EJ priority neighborhoods and where private tree planting space is scarce. Increase tree survival by funding a five-year

establishment period for each new tree planted and continue to work with community partners to expand planting in developed parks to mitigate tree loss.

- **Get creative about resolving space conflicts**. Pilot new approaches for managing right of way space, soil, and uses. Test technologies like flexible surfaces and expanded tree pits and explore creative uses of the right of way for trees and green infrastructure.
- Continue to **strengthen coordination between City agencies** in delivering tree services to the public and develop a coordinated and updated **citywide tree inventory system** to facilitate data collection and management.

CLOSE EQUITY GAPS IN TREE CANOPY COVER

We must ensure that the benefits of and responsibilities for our urban forests are shared equitably across communities. We need to continue to build community trust and collaborate with EJ priority communities to identify opportunities to co-design solutions that close disparities in tree canopy cover. We must:

- **Complete the Tree Canopy Equity and Resilience Plan** (funded to begin in 2023) to work with EJ priority communities to identify priority strategies and locations for planting, growing, and maintaining trees on private and public land and in the right of way, with a focus on low-canopy neighborhoods in EJ priority areas.
- Invest in implementing the resulting strategies with community-based partners to **increase equitable distribution and resilience of the urban forest and the communities surrounding it.**
- Identify opportunities **to focus City partnership planting and maintenance efforts in EJ priority areas and with impacted communities** to ensure resilience and co-benefits without exacerbating existing disparities.
- **Partner with impacted communities to identify strategies that invest in the design and implementation of job training and education programs** in EJ priority areas, including skill areas such as restoration and tree planting design and planning, and tree planting and maintenance work.

HELP OUR TREES AND RESIDENTS ADAPT TO AND WITHSTAND THE IMPACTS OF CLIMATE CHANGE

Seattle's urban forest is critical for building community resilience to withstand the increasingly frequent and devastating impacts of climate change, particularly for BIPOC communities that are hit hardest. While not addressed directly in the assessment, we know that Seattle's urban trees are also significantly impacted by climate change, specifically from increased heat and drought damage that and makes them more susceptible to pests and disease. In acknowledgement of these impacts, our recommendations also include those intended to mitigate climate impacts to our canopy. To achieve both, we must:

- **Plant trees suitable for Seattle's current and expected conditions** (i.e., native and adjacent-zone native species), and source trees from climate-adapted locations.
- **Increase maintenance funding** to ensure our trees are getting the care they need as they face more heat, less water, and higher susceptibility to pests and disease.
- Focus **planting and maintenance on heat islands and neighborhood hotspots** to increase canopy in communities that are vulnerable to heat events.
- Develop **proactive communications and management plans** to deal with new pests and diseases.

ALIGN HOUSING PRODUCTION AND TREE PRESERVATION AND PLANTING STRATEGIES

As our population grows and the city changes, we will need stronger tree protections to support the retention and replacement of trees. These protections should:

- Expand the **types and sizes of trees that are regulated**, including a new definition of significant trees and lowering the size threshold for exceptional trees. Apply replacement requirements to include significant trees 12 inches in diameter and larger.
- Require **mitigation** when trees do need to be removed and establish a **payment option** for when tree replacement cannot be done on site (payment in lieu).
- Allow for **adjustments to development standards** (e.g., setbacks, height, etc.) to accommodate retention of exceptional trees.
- Adapt the review process to allow for **expedited review** of development projects, and ensure a **clear, streamlined process** so all parties can communicate on tree issues early.
- **Reduce the limits** on homeowners' tree removals allowed outside of development.

APPENDIX

Appendix A: Canopy Losses and Gains by Management Unit

Appendix B: Tables of Development Parcel Data

Appendix C: Canopy Cover and Canopy Change in City Council Districts

Appendix D: Deciduous and Evergreen Trees

APPENDIX A: CANOPY LOSSES AND GAINS BY MANAGEMENT UNIT

Table 2 below shows the absolute losses and gains, and the percentage of canopy losses and gains, per management unit during the assessment period (2016-2021). This data is displayed graphically within the report (Figure 11).

Table 2. Canopy losses and gains by management unit[20]

Management Unit	2016 Canopy Area (Acres)	Canopy Loss		Canopy Gain		Net Change		2021 Canopy Area (Acres)
		Acres	Percent	Acres	Percent	Acres	Percent	
Neighborhood Residential	7,121	870	12%	783	11%	-87	-1.2%	7,034
Multifamily	952	135	14%	117	12%	-18	-2.0%	933
Right of Way	3,493	424	12%	414	12%	-10	-0.3%	3,483
Parks Natural Areas	2,176	182	8%	71	3%	-111	-5.1%	2,065
Developed Parks	708	60	8%	54	7%	-5	-0.8%	702
Commercial/ Mixed Use	352	51	14%	44	13%	-6	-1.6%	347
Manufacturing/ Industrial	212	32	15%	26	12%	-6	-2.9%	205
Major Institutions	241	33	14%	22	9%	-12	-4.8 %	230
Downtown	24	3	13%	3	13%	0	0	24
Citywide[21]	**15,279**	**1,790**	**12%**	**1,534**	**10%**	**-255**	**-1.7%**	**15,024**

[20] Due to rounding, some totals may not correspond with the sum of the separate numbers.
[21] Citywide row of Table 2 describes citywide totals and averages (not sums/averages of all management units).

APPENDIX B: TABLES OF DEVELOPMENT PARCEL DATA

Methodology: To assess the impact of development (building) on tree canopy, the SAL team analyzed canopy changes on parcels that were redeveloped between 2017 and 2021[22] and compared them to parcels where no development projects were completed during this time. "Redeveloped parcels" were defined as sites that began and completed construction of new buildings that added residential units or new commercial buildings within the identified timeframe. The analysis included canopy gains, losses, and net change, and the absolute and relative percent changes in canopy between 2016 and 2021 on this group of parcels citywide and grouped by management unit.

Table 3 below summarizes the results of this analysis citywide (across all management units). Table 4 summarizes parcel development data by residential category.

Table 3. Canopy change by parcel redevelopment status (citywide)

Citywide (All Management Units)	New Development Parcels	Parcels Where No New Development Occurred	Total
Total land area in 2021 (acres)	511	52,915	53,427
Canopy present in these parcels – 2016 (acres)	88	15,190	15,279
Canopy present in these parcels – 2021 (acres)	53	14,970	15,024
Relative % change in canopy 2016-2021	-39.8%	-1.4%	-1.7%
Net change in canopy in these parcels 2016-2021 (acres)	-35	-220	-255
Parcels where new development occurred represent 1.0% of total area in the city.			
The 35 acres of net canopy loss in developed parcels = 13.7% of the total acres lost in the city.			

[22] In this dataset, parcels that began and completed construction of new buildings that added residential units or new commercial buildings between 2017 and 2021 are included in the "Redeveloped Parcels" category. All other parcels are included in the "Parcels Not Redeveloped Category."

Table 4. Canopy change by parcel redevelopment status in residential management units

	Neighborhood Residential		Multifamily	
	Redeveloped Parcels	**All Parcels**	**Redeveloped Parcels**	**All Parcels**
Total land area in 2021 (acres)	142	20,841	149	4,074
Canopy present in these parcels – 2016 (acres)	50	7,121	28	951
Canopy present in these parcels – 2021 (acres)	33	7,035	14	933
Relative % change in canopy 2016-2021	-33.6%	-1.2%	-49.5%	-1.9%
Net change in canopy in these parcels 2016-2021 (acres)	-17	-87	-14	-18

Neighborhood Residential

- Parcels where new development occurred represent 0.7% of total Neighborhood Residential area in the city.
- The 17 acres of net loss in developed Neighborhood Residential parcels = 20% of the total acres lost in Neighborhood Residential areas.

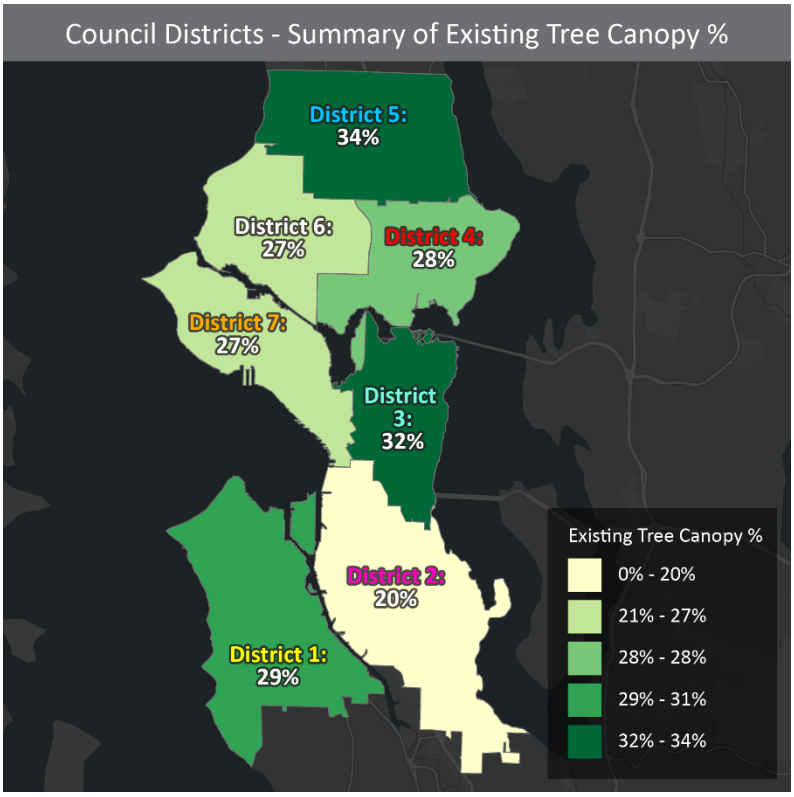
Multifamily

- Parcels where new development occurred represent 2.9% of total Multifamily area in the city.
- The 14 acres of net loss in developed Multifamily parcels = 78% of the total acres lost in Multifamily

APPENDIX C: CANOPY COVER AND CANOPY CHANGE IN CITY COUNCIL DISTRICTS

The maps on the following pages show 2021 canopy cover and relative percent change in canopy between 2016 and 2021 in each of Seattle's seven City Council Districts.

Figure 12. Maps of existing canopy cover by Seattle City Council District



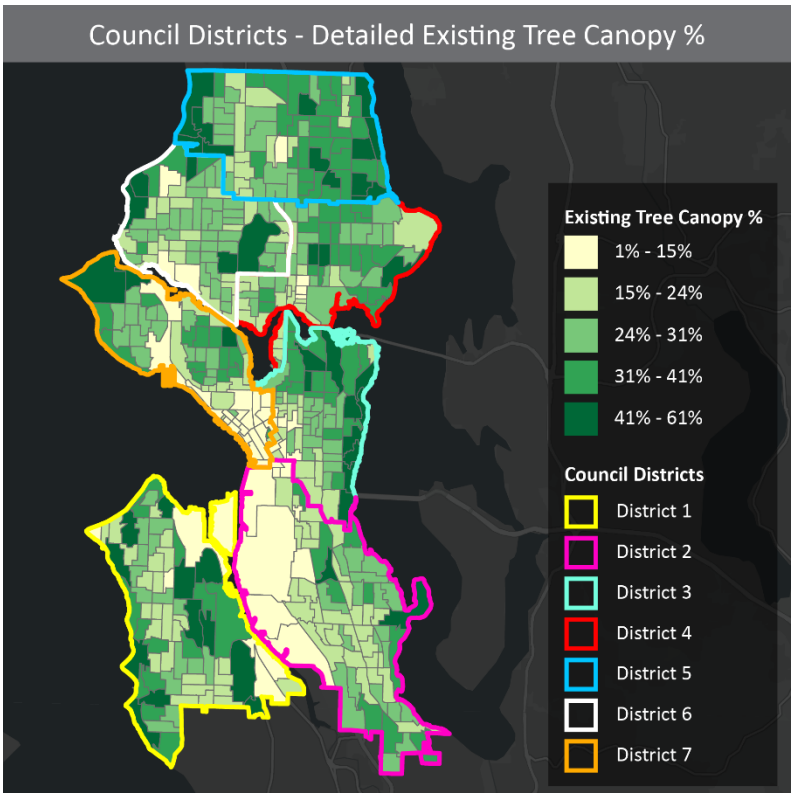
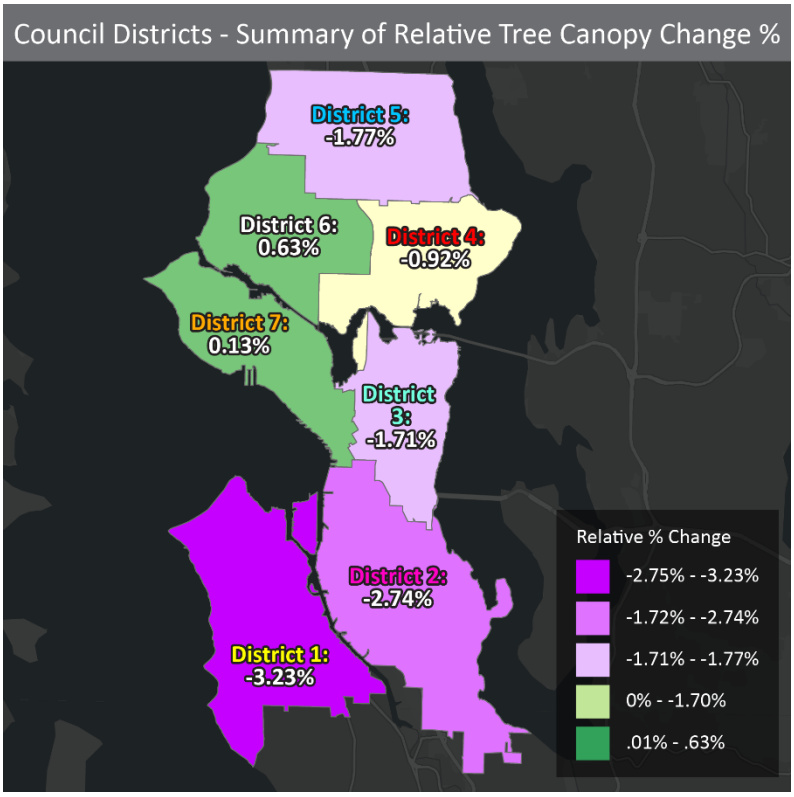


Figure 13. Maps of relative change in canopy cover by Census Block Groups, overlaid with Seattle City Council Districts



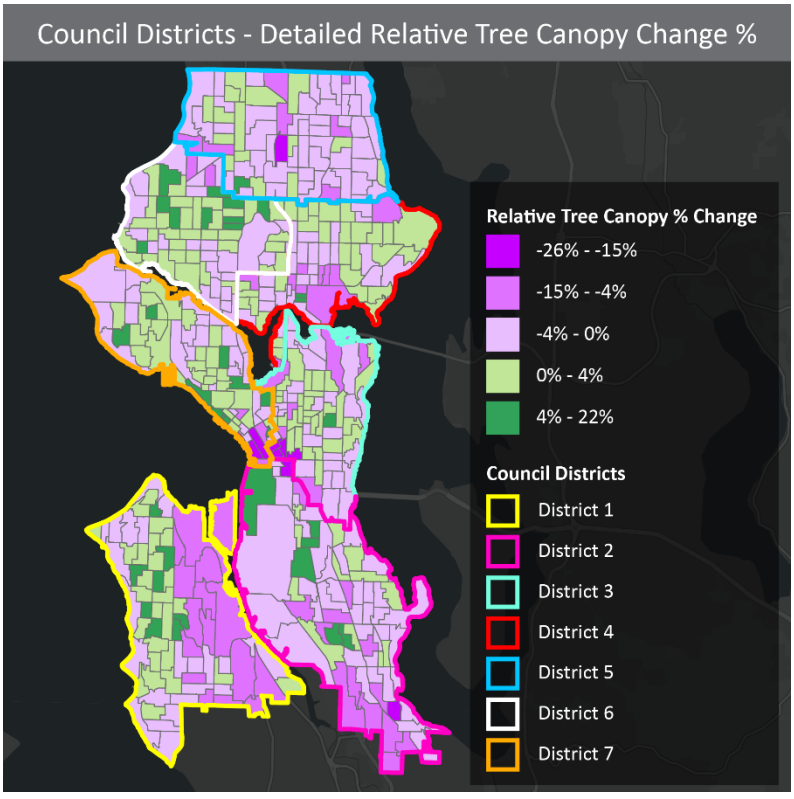


Table 5. Canopy cover and change by Seattle City Council District

Council District	2021 Canopy %	2021 Canopy Area (Acres)	Canopy Change 2016-2021 (Acres)	Relative % Canopy Change 2016-2021
1	29%	3,066	-103	-3.2%
2	20%	2,298	-65	-2.7%
3	32%	1,746	-30	-2.7%
4	28%	1,716	-16	-0.9%
5	34%	2,837	-51	-1.8%
6	27%	1,660	+10	+0.6%
7	27%	1,673	+2	+0.1%

Table 5 above shows the existing tree canopy percent and canopy area in each Council District, as well as the canopy change area and relative percent change between 2016 and 2021.

Findings

All but two Council Districts saw a net loss of tree canopy. Districts 6 and 7, which are not within EJ priority areas and have significant park areas (Discovery and Golden Gardens Parks), gained canopy during the assessment period.

Six of the Council Districts are at or above the citywide canopy average of 28.1%. These Districts had canopy ranging from 27-34% in 2021. District 2 in southeast Seattle currently has a much lower canopy than these Districts, at 20%. This lower canopy is partially explained by the large amount of industrial land in this area, but still points to the need to focus tree canopy restoration efforts in the southeast part of the city for the benefit of residential neighborhoods there.

APPENDIX D: DECIDUOUS AND EVERGREEN TREES

Deciduous and Evergreen Trees

Prior to European settlement, Seattle's native forest had a higher proportion of evergreen trees, which keep their leaf cover year-round, and fewer deciduous trees, which lose their leaves annually. Due to their longer lifespans and constant leaf cover, evergreen trees provide greater ecosystem services over time, like intercepting more rainwater and absorbing more pollutants. Around homes, they provide year-round privacy and wind protection.

The City prioritizes evergreen trees by:

- Actively promoting conditions for evergreens to thrive and planting them in natural area restoration efforts.
- Encouraging residents to choose evergreen species for planting where appropriate.
- Selecting evergreen species where appropriate for street trees and park plantings.

The city's forest composition began to shift as the majority of trees were clear-cut and replaced with deciduous and non-native trees. Much of this second-growth forest is reaching the end of its lifespan and dying at a greater rate as deciduous trees face climate change impacts. We are working to return Seattle's forest closer to its native composition; the assessment shows that in 2021, **37% of Seattle's trees were evergreen, a 9% increase from 2016**.

City of Seattle