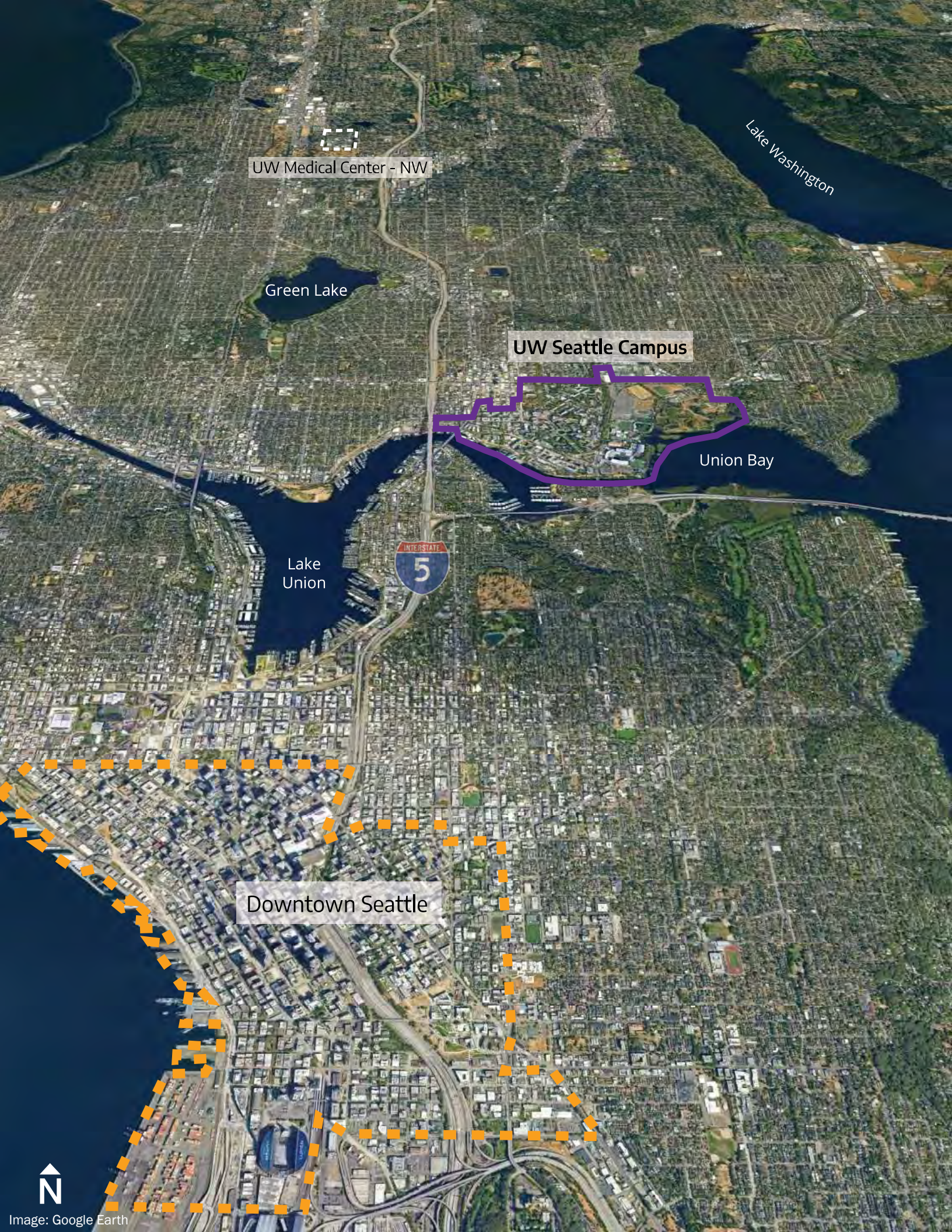
Campus Architecture & Planning / Updated in April 2024

URBAN FOREST MANAGEMENT PLAN


UW Medical Center - NW
Lake Washington
Green Lake
UW Seattle Campus
Union Bay
Lake Union
INTERSTATE
5
Downtown Seattle
N
Image: Google Earth

Land Acknowledgment

The University of Washington acknowledges the Coast Salish peoples of this land, the land which touches the shared waters of all tribes and bands within the Duwamish, Suquamish, Tulalip, and Muckleshoot nations.

TABLE OF CONTENTS

Purpose of Plan

VISUALIZING | ANALYSIS | VISIONING | PLANNING

The University of Washington takes pride in the quality of the natural environment of this region and on campus, illustrated by the landscape's complex and diverse character. To preserve its beauty and function, the University actively plans and develops strategies for protecting it in the face of new development. The Urban Forest Management Plan helps align various planning studies with the conservation and enhancement of the University's urban forest. The following goals provide the framework that becomes the lens by which strategies are development through a thoughtful analysis of the tree canopy and resources.

Effectively **communicate the value** of the University's urban forest canopy relative to diversity of species, air quality, storm water, and well-being for humans and wildlife. Identify benefits or deficits associated with increasing or decreasing our urban forest on campus balanced with open space needs and access to daylight. Establish metrics for measuring the benefits of increasing the urban forest or the deficits associated with decreasing the urban forest on campus.

Identify **canopy coverage goals** to include percent cover in each campus neighborhood. Establish tree planting locations for large and small scale plantings; formal and informal plantings; naturalized and habitat enhancing locations; and general guidelines for selecting species and planting locations.

Identify opportunities to **become better stewards** of the urban forest through best management practices for protecting, planting, transplanting, wood reuse, and maintaining the trees on campus during establishment and long-term care. Provide standards for protection, replacement, and removal. Establish a tree replacement policy for tree loss due to disease, climate change, or construction.

Increase general knowledge and awareness of the urban forest through the development of campus tree tours, walking maps, and informative posters; establishing access to an online campus tree database; tree planting work parties including Tree Campus USA and Arbor Day celebrations; and working with students to develop capstone projects and faculty to identify resources to enhance teaching.

Maintain a **current and dynamic tree database** for all trees on campus with information related to tree species, size, health, value, maintenance records, etc. Increase safety on campus by identifying and removing high risk trees and tree parts. Identify concerns related to trees with a high level of disease susceptibility or high risk areas based on adjacent use.

Implement management strategies that are acknowledged, understood, and accepted by relevant municipal departments as regulated under the 2019 Campus Master Plan.


1

Intro to Urban Forestry

The clearest way into the Universe is through a forest wilderness. John Muir

The majestic views of trees in the foreground and mountains in the background give Western Washington its iconic character. The landscape's historic condition has been substantially disturbed by urbanization, leaving us with relics of its old-growth character. The history of the Pacific Northwest forest is built on narratives of different management strategies, each signifying changes in development and our understanding of ecology. Today, we are required to develop policies that support the re-establishment, enhancement, and protection of urban forests. As the pressure of development continues in Seattle, balancing open space with buildings is pivotal for maintaining the natural experience in the city. The City of Seattle has established a standard for managing its urban forest through a sustainable framework that considers ecological, management, and stewardship goals as overlapping pillars for maintaining a healthy and vibrant urban forest. The University shares similar values as the city, working towards identifying and overcoming the challenges of maintaining the tree canopy.

Washington's Forestry Past

LOGGING | MILLING | BUILDING

The woodland stands of fir, hemlock, spruce, and cedar have long been a symbol of the Puget Sound region. Historically, the canopy of trees was actively managed by Indigenous peoples for food, clothing, ceremonies, and housing. Colonization brought increased harvesting of the trees without consideration for the health of the forest. The history of local forest management can be divided into four time periods of significance, each representing a different ideology of how to sustain their production into the future.

PRE-COLONIZATION : before 1848

Prior to European settlement, Indigenous people harvested and managed the trees to meet their needs and those of the forest. They tended the forest and in return the forest species provided for them; for example, western redcedar trees were used to make ceremonial structures and dug-out canoes. Burning practices were common among Indigenous groups as they encouraged the growth of food crops such as camas and huckleberry and increased hunting opportunities. In 1828, the Hudson's Bay Company expanded their economic efforts beyond the fur trade by building a lumber mill at Fort Vancouver, dramatically transforming how the forest of the Northwest was used and valued.

THE RISE OF THE LUMBER INDUSTRY : 1848 - 1883

The gold rush of 1848 sparked a growing demand for lumber used for steam powered engines and as structural supports in mining tunnels. In addition, lumber was increasingly harvested to build housing and shops in burgeoning mining towns and lumber camps. By the mid-1850s there were over 100 mills in the Puget Sound region, run by lumber barons who saw this region's forests as an inexhaustible resource. This period also saw an increase in illegal logging and timber theft along with high levels of corruption within the industry.

TECHNOLOGY, RAILROADS, AND CAPITAL : 1883 - 1940

The expansion of the railroad throughout this region and beyond provided greater access to harvestable land along with expanding timber markets across the country. This paired with advancements in logging technology resulted in dramatic increases in lumber production. This period also marked the beginning of government intervention through policy developed to limit the negative impact of logging activities on watersheds. The first head of the U.S. Forest Service, Gifford Pinchot felt that old-growth forests were wasteful because they grew very slowly. This encouraged the harvesting of old growth forests to be replaced by a younger faster growing stands for production purposes. Wars, along with the Great Depression, caused the lumber industry to be in constant flux during this period. From 1905 to 1930, Washington was the nation's leader in timber production until Oregon began producing more in 1931.

INTENSIVE LOGGING AND ENVIRONMENTALISM : after 1940

The lumber industry lost its dominance in Washington's economy during WWII. Most of the lumber harvested after the war went towards pulp and paper due to a change in demand. The lumber Industry continued to grow steadily, while other industries like airplanes, weapons, and other goods grew much faster. Timber prices rose substantially as the private supply of trees declined. The U.S. Forest Service encouraged rapid logging and intensive management. They were optimistic that the high levels of production could be sustained as technology and scientific expertise would prevent depletion.

Source: National Archives and Records Administra-

FORESTRY TODAY: 2023

Today, the Washington State Department of Natural Resources (DNR) and the U.S. Forest Service help manage the forest through policy and oversight of both private and public forests. One thing to note is that Western and Eastern Washington manage their forest differently due to variations in climate and forest stand species. In Western Washington, foresters practice clear-cut harvesting which allows for new seedlings to grow by reducing the competition for light. The Forest Practices Rules governed by the DNR establish laws that define what proper management of forests looks like in Washington. These laws do not impact urban forestry, which is managed and governed by local municipalities.

WASHINGTON FORESTRY TODAY

- **18 million acres of Timberland in Washington**
- **Washington harvested 2,389,556,000 BF in 2022**
- **King county harvested 87,924,000 BF in 2022**

↑ The US Army Corps of Engineers built the Lake Washington Ship Canal and the Hiram Chittenden Locks to allow passage between fresh water Lake Union and salt water Puget Sound. Photo taken November 25, 1917

↓ Urban Forestry has become a prominent research focus of cities due to their relationship with public health, ecological processes, economic development, and livability.

Seattle's Urban Forest

SUSTAINABLE | RESEARCH | MANAGEMENT | COMMUNITY

The City of Seattle has a long history of supporting urban forestry in the region because of their awareness of the value trees provide in creating a livable and healthy city. Sited properly, trees can help extend the life of existing infrastructure by leveraging natural systems as green infrastructure. They can reduce reliance on engineered infrastructure while increasing the ecological health of an area.

The management of an urban forest differs from that of a natural setting due to the increased complexity related to development, public safety, infrastructure above and below ground, pollution, and transportation. In addressing these challenges, the City has adopted a sustainable model for managing its urban forest. The sustainable model places a higher value on the services of the forest rather than on the production of goods. The City's model identifies three primary management strategies for monitoring and improving the existing urban forest:

Tree Resources: an understanding of the trees themselves, as individuals or in forest stands.

Management Framework: assignment of responsibility, resources, and best practices for the care of trees.

Community Framework: the way residents are engaged in planning and caring for trees.

The management of Seattle's trees occur through multiple departments of city government: Seattle Department of Transportation manages street trees, Seattle Parks and Recreation manages park trees, Seattle City Light maintains trees around utilities, Seattle Public Utilities manages trees along creeks, and Seattle Department of Construction and Inspections directs tree preservation on private properties. The diverse nature of the urban environment and multiple managing bodies makes a comprehensive plan important for aligning efforts across landscape types amongst different stakeholders. To establish realistic urban forest goals, the City established unique goals based on different land use types (single family, multi-family, institutional, industrial, etc.) with a citywide goal of 30% and an institutional canopy goal of 20% by 2037.

SEATTLE'S FORESTRY STRATEGIES

- **Optimize Forest Health & Environmental Benefits**
- **Increase Canopy Understanding**
- **Support Interdepartmental Efforts**
- **Proactive Management & Preservation**
- **Increase Public Awareness & Support**
- **Model Good Stewardship**

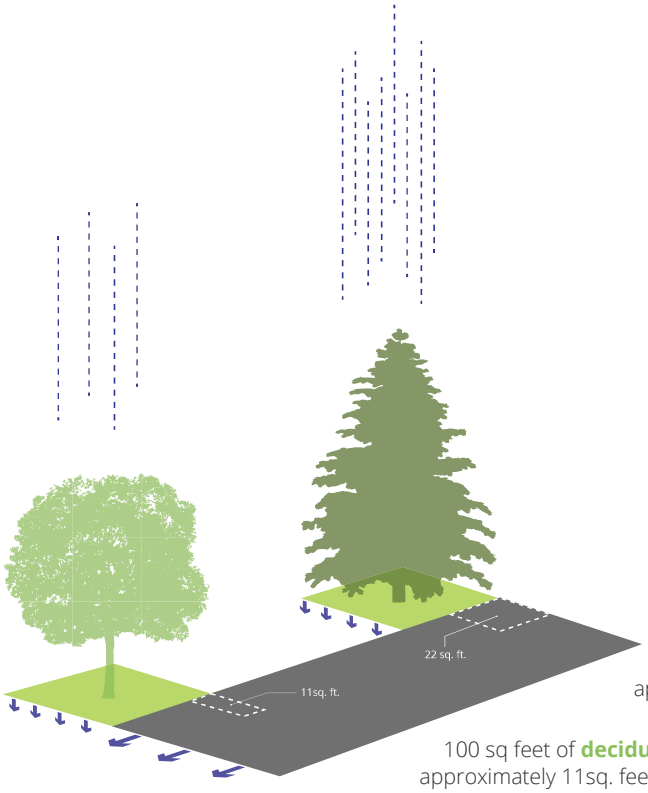
The Value of Urban Trees

ECOLOGICAL | SOCIAL | CULTURAL | VISUAL | PHYSIOLOGICAL

Urban trees provide valuable benefits to human health, ecology, and livability, especially in the face of climate change. Overall, trees help make urban environments more livable through reducing heat island effects; cleaning the air, water, and soil; providing habitat for wildlife; and contributing aesthetic beauty throughout the seasons. As trees age their benefits grow with their trunk size. Research describes a positive relationship between the presence of trees and human health, safety, creativity, social values, and decision making. To maximize their value, trees should be properly planted and maintained by the local municipality and residents based on the specific requirements of the species and the growing conditions. The following pages describe some of the many benefits trees provide that improve the living conditions in cities.

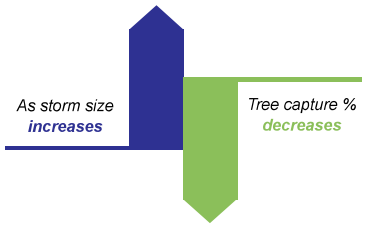
STORMWATER MANAGEMENT

Trees reduce the volume of stormwater that enters municipal infrastructure and public waterways by absorbing runoff through their roots and releasing it into the air through evapotranspiration. These processes result in improved water quality in addition to less water quantity arriving at municipal water treatment plants. Trees can manage stormwater from a surface equivalent to 10 - 20% of their canopy area. Green stormwater infrastructure should be used alongside trees to fully manage stormwater on individual sites. In the Northwest, deciduous trees are dormant during the "wet" season, which reduces their stormwater management value in comparison to evergreen trees.

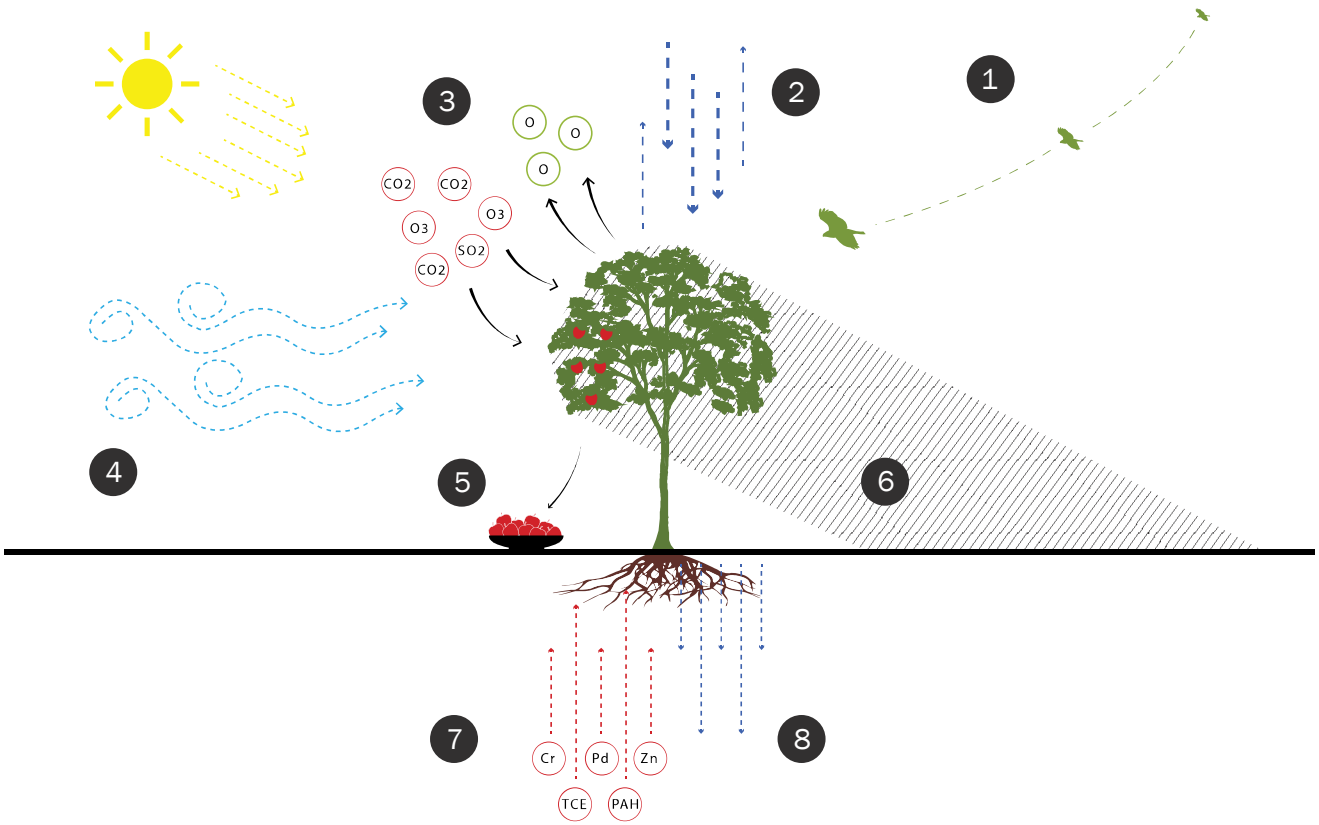


100 sq feet of **evergreen tree canopy manages** runoff from approximately 22sq. feet of nearby impervious surface

100 sq feet of **deciduous tree canopy manages** runoff from approximately 11sq. feet of nearby impervious surface



Deciduous Trees capture **1/2** the stormwater volume as **Evergreen Trees**



ECOLOGICAL BENEFITS

1 *Habitat*

Trees provide food, shelter, and water for wildlife. Habitat benefits vary based on tree density, health, and species varieties.

2 *Stormwater*

The size and type of tree determines how much stormwater it can absorb, intercept and evapotranspirate, which are important aspects of the water-cycle.

3 *Air Quality*

Trees aid in improving air quality by absorbing greenhouse gases and other toxins while releasing oxygen back into the environment.

4 *Wind*

Siting trees perpendicular to prevailing winds helps dissipate the power of the wind and can make harsh urban environments more pleasant.

5 *Food*

Trees can provide food for both human and wildlife consumption. Tree selection defines the types of food produced and their ecological benefit.

6 *Microclimate*

The shade produced by trees creates microclimates in the city and reduces the ambient air temperature within shaded areas up to 23 degrees.

7 *Phytoremediation*

A select group of trees have the ability to uptake or stabilize contaminates within soil. Tree selection needs to be correlated with the existing soil toxin.

8 *Ground Water*

Trees promote the natural infiltration of stormwater, with their roots helping clean the water prior to it entering the ground water.

VISUAL BENEFITS

The visual presence of trees has been found to meaningfully reduce the stresses associated with living in urban areas. Trees can also help increase attention spans, improve memory, and inspire creativity in addition to other physical and emotional health benefits.

PLANT TREES FOR SAFETY

Trees have been shown to make a place safer when they do not obstruct views at eye-level. Research has found that there is a relationship between obstructed views from first-floor windows and an increase in crime. In residential buildings, the top of first floor windows is on average 8.7 feet above grade. Recognizing this relationship can aid designers and managers in creating safe and pleasant environments across campus.

62%

of students say, "appearance of **GROUNDS** and **BUILDINGS** is the most influential factor during a campus visit"

Jackson, 2002

INFLUENCE OF CAMPUS LANDSCAPES

Research has shown that prospective students are greatly influenced by the appearance of the landscape during a campus visit making maintenance integral to a university's success.

What Students Notice During a Campus Visit

Clean, well-kept or orderly campus	*24%*
Pretty, beautiful or nicely landscaped	*24%*
Largeness of campus	*24%*
Architecture of buildings	*20%*
Friendly or happy place	*15%*
Traffic	*14%*
Smallness of Campus	*14%*
Campus Layout	*11%*
Town/city atmosphere	*6%*
Dorms/living arrangements	*5%*

Environmental Context

TEMPERATURE | RAINFALL | SOIL | SUN

Seattle's climate is described as temperate marine or Mediterranean, characterized by cool, wet winters and warm, dry summers. On average, Seattle receives only 4 to 6 inches of rain from May to September compared to 30 inches from October to March. This condition requires plants and trees to be irrigated during summer months, especially for establishment. This condition makes rainwater harvesting for summer irrigation challenging because of the lack of rain and the scale of the system required to provide significant water for the dry months.

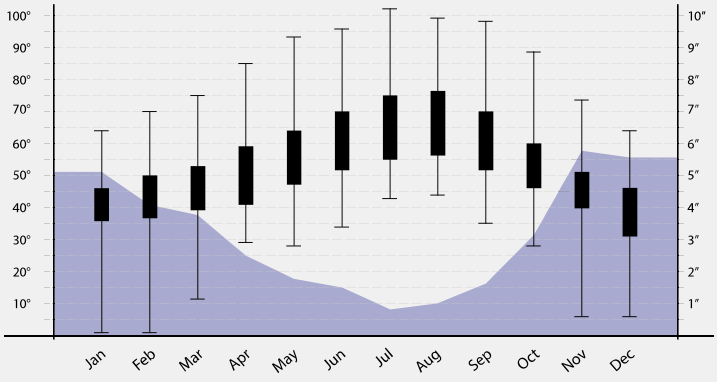
Seattle's Hardiness Zone is 8b or 15°- 20°/ 24"- 48", meaning this area has a low temperature of 15-20 degrees Fahrenheit with 24 - 48 inches of rain annually. Climate change has the potential to shift hardiness zones to the north making our climate warmer and drier which could alter the types of trees and vegetation that may thrive here in the future. Local cities are beginning to experiment by planting new varieties of trees from hardiness zones to the south as test species for the future.

The sun path of this region encourages planting deciduous trees on the south and west sides of structures to reduce the amount of solar gain during the summer that reverses in the winter after they have lost their leaves. Evergreen trees provide shade and wind barriers all year long.

One of the most challenging aspects of this region's ecology is the soil. Large deposits of a thick clay layer called Vashon Till were created during the ice age as the Vashon Glacier repeatedly advanced and receded thousands of years ago. The Vashon Till layer underlies most of the city, making drainage poor, establishing vegetation difficult and installing low-impact design strategies complex. Existing environmental conditions need to be evaluated prior to tree selection to identify a species best suited for the site.

Average Annual Temperature and Rainfall

The Mediterranean climate of Seattle has warm dry summers with wet cold winters.



Hardiness Zone

Seattle is located in the 8b zone which promotes plants that are hardy down to 15 to 20 degrees.

Development & Forest Ecology

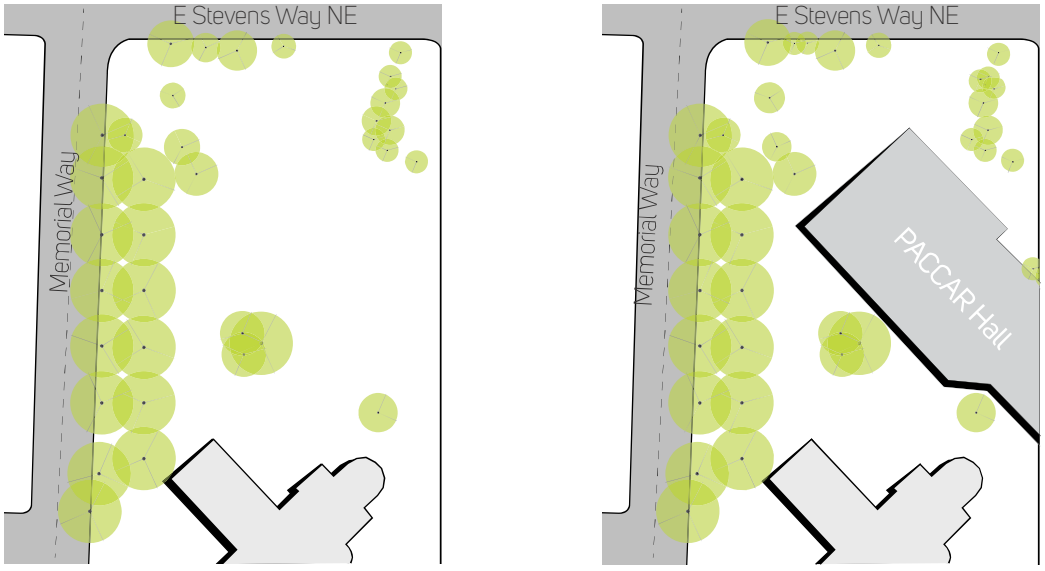
BIOTIC | ABIOTIC

Urban forests are constantly being impacted by both human and environmental factors. They are often reshaped by the construction of buildings and roads, infestations of disease and insects, and physical damage caused people and weather. Natural disturbances allow a stand to become more resilient, while development can limit the functions of the urban forest. The University recognizes the need for the landscape to change and evolve to meet the growing demand for new spaces where students, staff, and faculty can learn, live, work, and play; while also trying to maintain the integrity and grandeur of the campus's natural environment.

Managing the Urban Forest

Since 2000, improvements and new construction has been constant across campus resulting in new buildings, enhanced landscape features, increased accessibility, and expanded building footprints. With more development planned, a strategy for maintaining and managing the University's natural environment is critical. The volume of projected growth makes establishing and achieving a static canopy goal difficult because with each new project comes new impacts that will alter the existing ecology of a site and potentially the University as a whole. Instead, the primary goal becomes developing a management strategy that strengthens the presence of nature and its function while allowing for the expansion of land uses on campus. A balance between nature and edifice is required in the design, planning, and vision of the University of Washington Seattle campus.

PACCAR Hall Design Example



Existing Condition

Final Design Plan

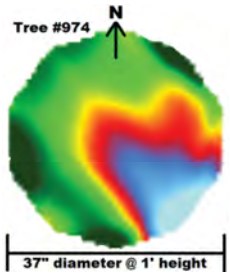
Many of the areas on campus that are prime for new development are currently covered with lush, mature trees and vegetation. As development is proposed on these sites, creative site planning will be critical for preserving the existing ecological function of the site while maximizing the building's footprint.

Environmental Hazards

WIND | PERCIPITATION

The trees on campus are evaluated for their risk of failing during weather events such as high wind or sustained rain. Risk assessments consider how close a tree is to people, roads, and structures. A hazard tree is one that has been assessed to have unacceptable levels of risk and must be removed. Tree risk assessment are completed by the Campus Arborist and third-party arborisits. Arborists use a variety of tools to find rot and other structural issues that may make a tree vulnerable to the effects of wind and rain. Tree assesment tools include trained visual observance of the individual tree and site conditions and technology such as a micro-resistance drill and the ArborSonic 3D Acoustic Tomograph. Trees are pruned or removed based on arborist recommmendations.

The Campus Arborist uses the International Society of Arboriculture "Tree Risk Assessment" form to assess and document the risks associated with individual trees that have been identified as potentially dangerous. This form helps the University determine the necessary means for resolving the hazard. In the event that a large tree is suspected to be a high ristk, a third-party arborist is engaged to determine the level of risk and possible mitigation measures.



Sonic tomography uses sound waves to detect decay within a tree. The image above reveals trunk decay, in blue, of a poplar tree near Montlake Blvd and the Golf driving range.

Quercus rubra *failure on September 27, 2023 in Grieg Garden. This tree had a large, lopsided canopy, full with leaves weighted toward the side of the failure. This tree was assessed after it fell by a third-party arborist, who determined the cause of failure as rain saturation of the soil and wind combined to destabilize the healthy root system.*


2

Urban Forest Planning Principles

From little seeds grow mighty trees.

Aeschylus

To establish goals and strategies related to the urban forest, a baseline needs to be defined for which all future changes will be compared with to understand the progress and value of subsequent efforts. As part of this analysis, the campus is evaluated as a whole and as four distinct neighorhoods to identify multi-scalar aspect of the system that can be improved to acheive our urban forestry goals. The multi-scalar analysis of the University's landscape results in a range of recommendations and insights that address both short-term and long-term strategies for improving the urban forest. The strategy also explores the different roles trees can play in shaping the campus environment though their scale, agglomeration, alignment, and context. The use and function of trees on campus should be considered based on the tree planting mosaic in which they are located to create a mutually beneficial relationship between site, nature, and architecture. These relationships will be important to consider as the University works towards increasing the canopy cover to 150 acres by 2037.

Tree Canopy Goals

UPPER CANOPY | LOWER CANOPY | UNDERSTORY

The City of Seattle has defined a canopy cover goal of 20% for all Institutional properties by 2037. This percentage is derived by dividing the total canopy area by the total area of land including buildings and the public right-of-way. Based on data from the 2021 Seattle LiDAR scan, the University has exceeded the city's goal for institutions with 24% canopy. When only accounting for the area of campus that has been surveyed, the campus is two percentage points over the city's goal. The areas of campus that have yet to be surveyed include Kincaid Ravine, Union Bay Natural Area, and Pend Oreille which have some of the densest groves of trees on campus. Having already met the city's canopy goal, the University has defined a goal of 25% canopy cover by 2037 which is an increase from 146 acres to 150 acres of canopy cover. The strategies and policies to meet this goal are outline throughout this document, including identifying missed opportunities and promoting established practices. Achieving 150 acres of canopy will require the allocation of more resources to managing the University's urban forest. Urban forestry needs to be a major topic of discussion during campus planning and design processes because it will continue to be a part of the University of Washington's legacy.

Tree Canopy Coverage

20%
City's Institutional Canopy Goal

24%
Current University Canopy*

25%
University Canopy Goal for 2037

Maintain 150 acres of canopy through 2037

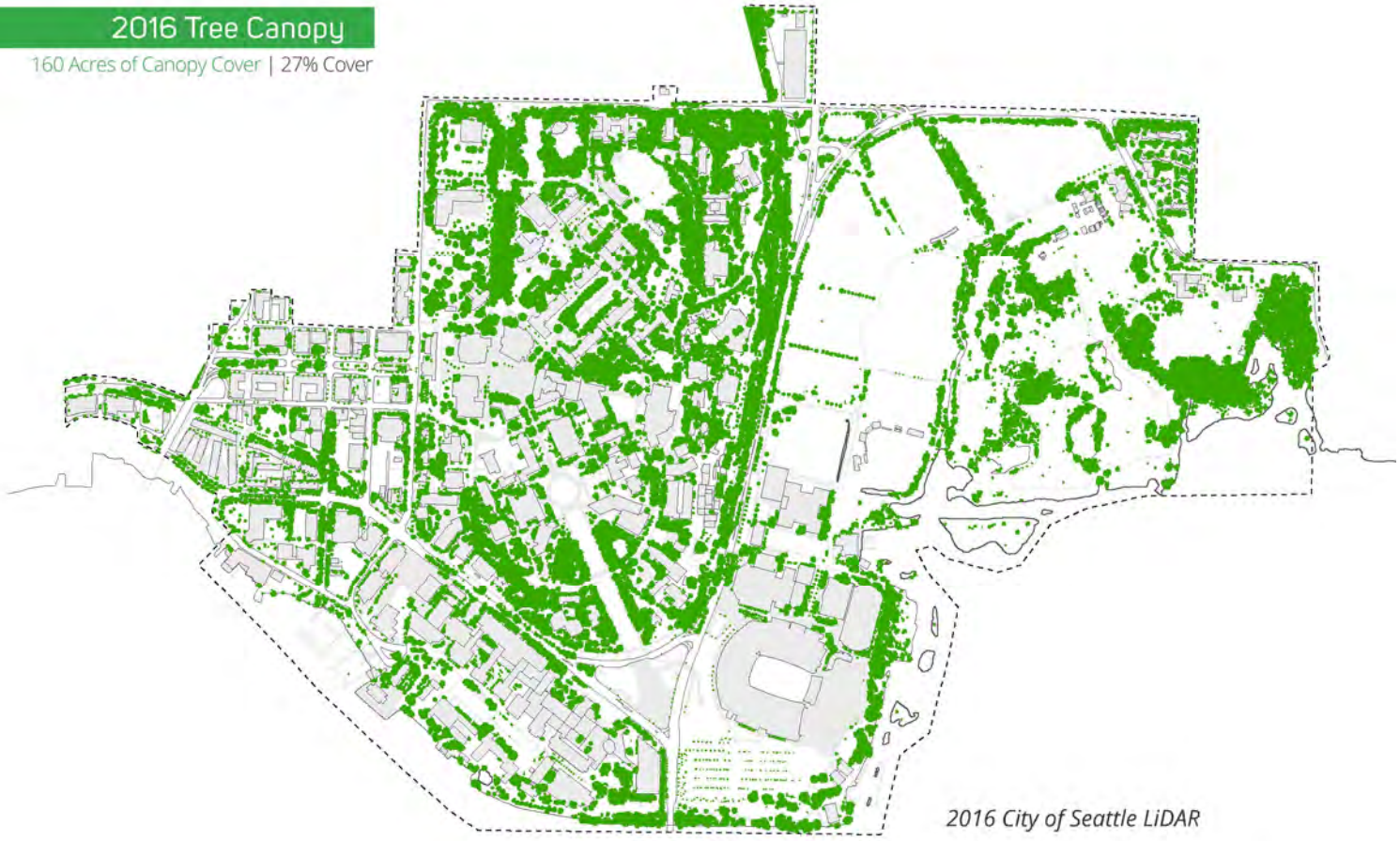
21%
of Campus Canopy is in Non-Surveyed Areas

79%
of Campus Canopy is in Surveyed Areas

**Based on the LiDAR scan of Seattle performed in 2021 by the USGS.*

2016 Tree Canopy

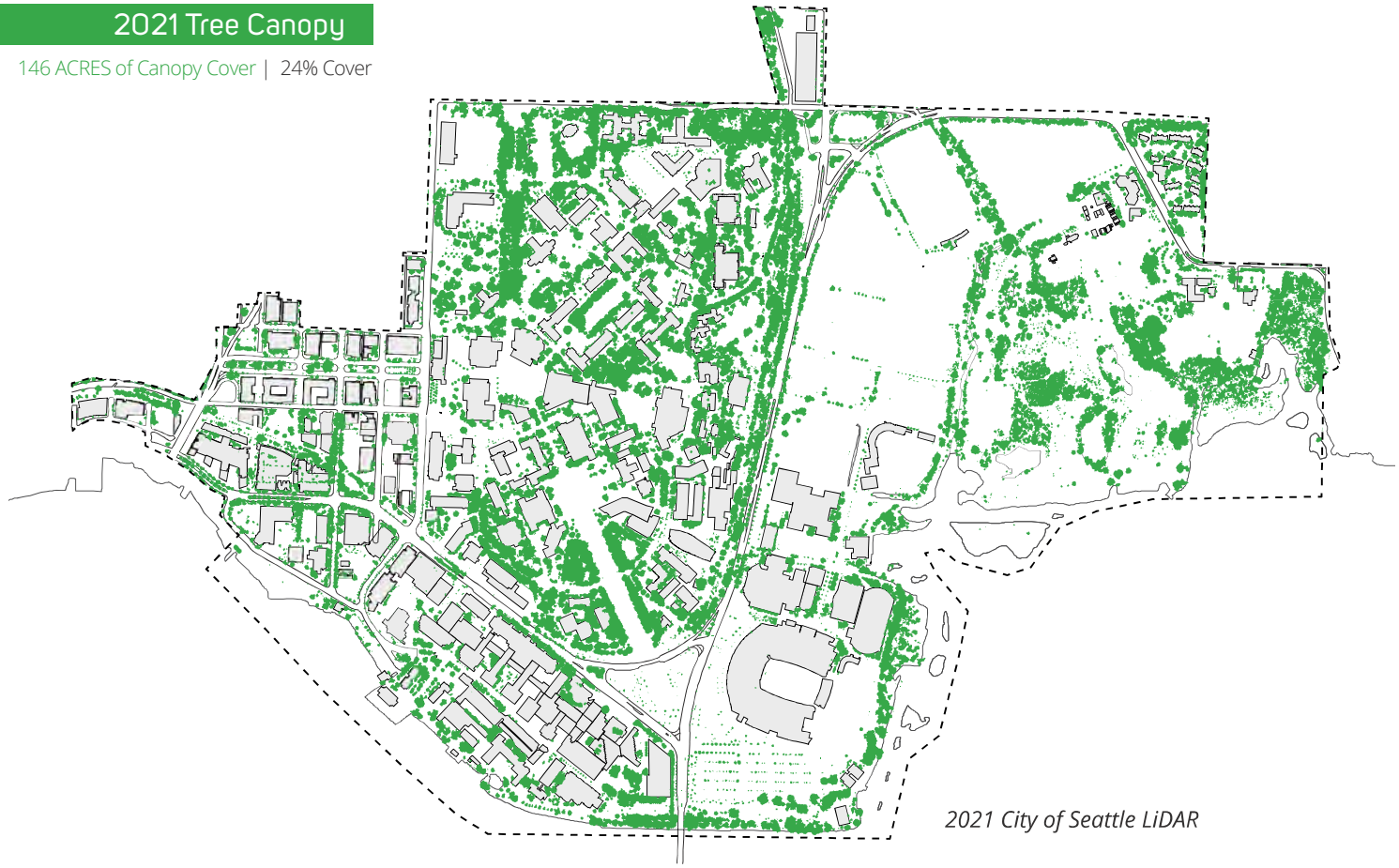
160 Acres of Canopy Cover | 27% Cover



2016 City of Seattle LiDAR

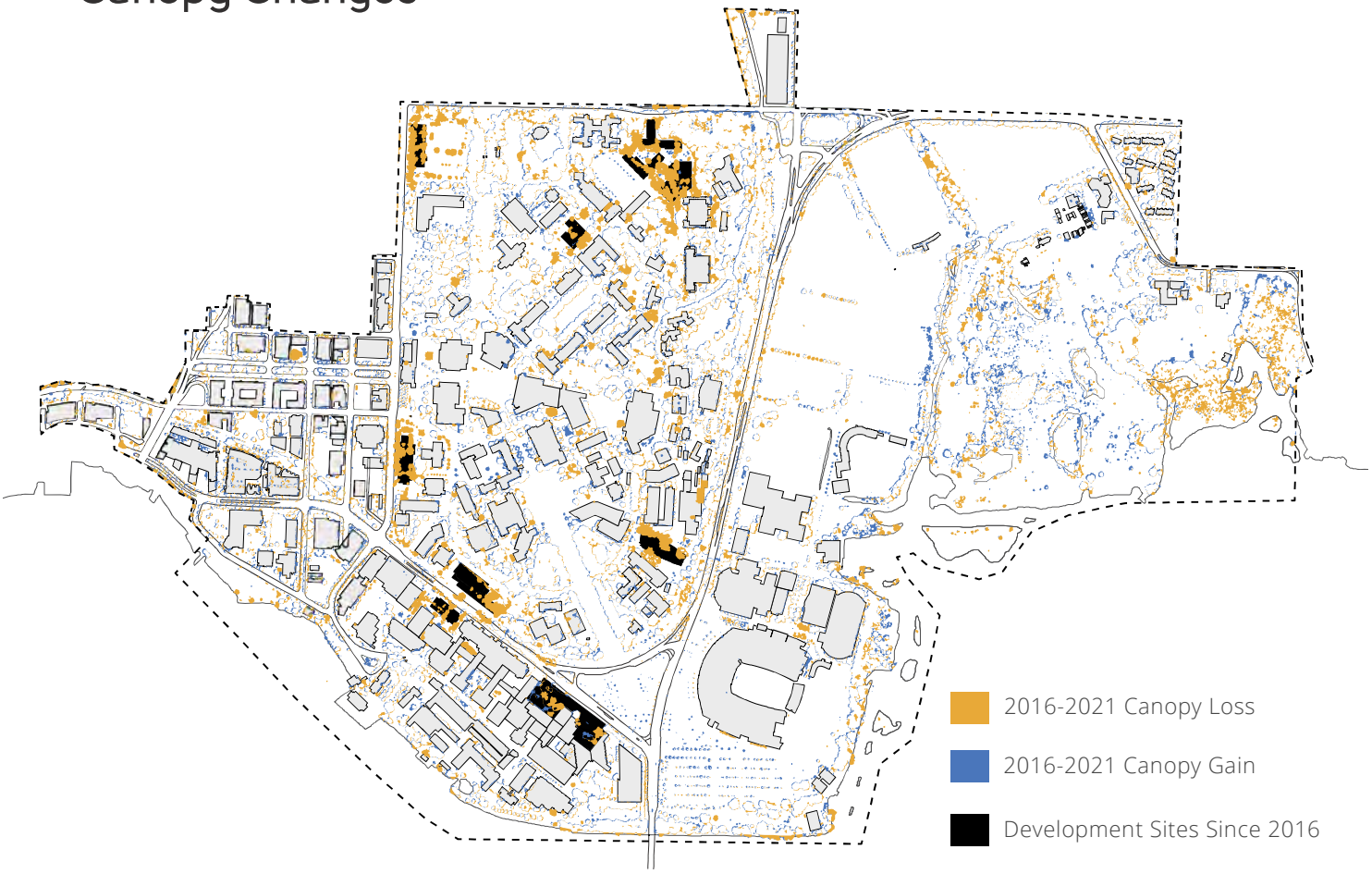
2021 Tree Canopy

146 ACRES of Canopy Cover | 24% Cover



2021 City of Seattle LiDAR

Canopy Changes



The UFMP analyzes the most recent LiDAR data to understand the campus tree canopy status and set goals. The first UFMP was published in 2015; however, at the time, the most recent data available was from a 2003 aerial scan of the City of Seattle. Another scan was completed in 2016 and showed the goals from the 2015 UFMP were surpassed. This data lag made the current update essential. The 2021 LiDAR scan became publicly available during the summer of 2023 and initiated the process of this revision. Although this version is published with 3-year old data and the canopy is always changing, this plan tells the story of changes in canopy between data frames.

Based on the data available, it appears the campus canopy grew between 2003 and 2016. Campus development slowed as the University was in the final phase of a master plan and a global recession hit in 2009. The University earned the Tree Campus USA certification during this period. Many trees were planted in the Union Bay Natural area as part of restoration and research efforts. However, between 2016 and 2021 we saw a decrease in overall campus canopy due to a myriad of impacts. The surge in gross square feet of development since 2016 has necessitated the removal of many mature trees, as illustrated in the map above. While the University has replaced these trees at a 2:1 ratio, many of them do not show up in the current LiDAR scan. Warming temperatures, wetter winters, and hotter, dryer summers has stressed many species of trees across campus and made them more susceptible to disease and pests, resulting in wide-spread tree decline and removal. Throughout the Union Bay Natural Area, increased beaver activity has resulted in significant loss along the entire shoreline. These impacts will be discussed in more detail in later pages. Despite development and climate change-related impacts, this plan envisions canopy growth for the next decade.

Canopy Status Review

NEIGHBORHOOD	CANOPY SINCE 2003*	CANOPY CHANGE
CENTRAL CAMPUS 215 ACRES	2003 Canopy Status : 67 acres 2015 UFMP Goal : 75 acres 2021 Canopy Status : 78 acres	Canopy Change 2003-2016 : +17 acres Canopy Change 2016-2021 : - 6 acres
SOUTH CAMPUS 57 ACRES	2003 Canopy Status : 7 acres 2015 UFMP Goal : 7.7 acres 2021 Canopy Status : 9 acres	Canopy Change 2003-2016 : + 4 acres Canopy Change 2016-2021 : - 2 acres
WEST CAMPUS 69 ACRES	2003 Canopy Status : 6 acres 2015 UFMP Goal : 12.1 acres 2021 Canopy Status : 12 acres	Canopy Change 2003-2016 : + 7 acres Canopy Change 2016-2021 : - 1 acre
EAST CAMPUS (NO U.B.N.A.) 173 ACRES	2003 Canopy Status : 14 acres 2015 UFMP Goal : 19 acres 2021 Canopy Status : 22 acres	Canopy Change 2003-2016 : + 9 acres Canopy Change 2016-2021 : - 1 acre
EAST CAMPUS U.B.N.A. 83 ACRES	2003 Canopy Status : 11 acres 2015 UFMP Goal : n/a 2021 Canopy Status : 25 acres	Canopy Change 2003-2021 : + 18 acres Canopy Change 2016-2021 : - 4 acres
TOTAL 597 ACRES	2003 Canopy Status : 105 acres 2015 UFMP Goal : 23% (137 acres) 2021 Canopy Status : 146 acres	Canopy Change 2003-2016 : + 55 acres Canopy Change 2016-2021 : -14 acres

**Based on the LiDAR scans of Seattle performed in 2003, 2016, and 2021 by the USGS.*

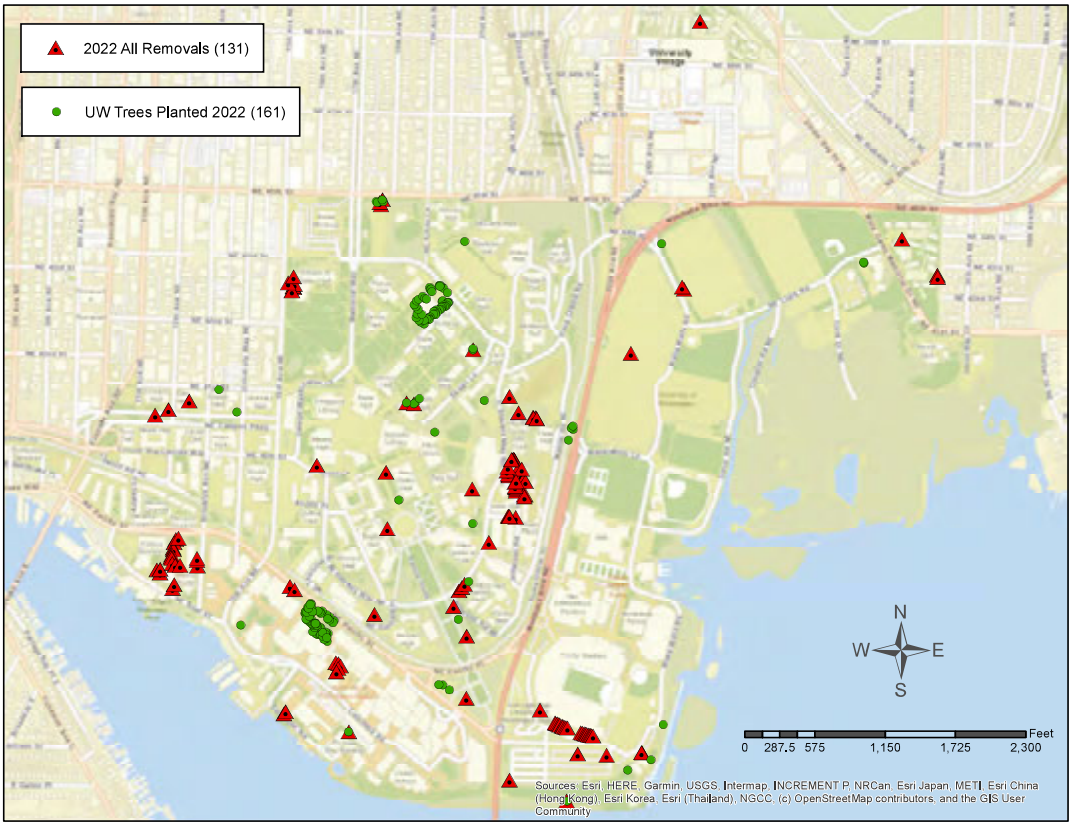
Metrics and Reporting

CANOPY GOALS | TREE HEALTH

The University continuously strives to better understand its urban forest resources. With the goal of being good stewards of the trees, the University will track several metrics including, diversity of trees, canopy cover change, tree structural condition, and tree health condition. The diversity of trees should include a mix of ages, species, and genus to overcome disturbance and ensure the longevity of the forest resource. The canopy cover change will be measured against the canopy cover goal set by this document. Periodic updates to this document may be made as we approach the goal deadline. Tree condition data will be gathered by a third-party arborist in association with major construction projects and will be retained internally. The metrics of these categories will be used to inform and guide management decisions in the future.

Timeframe	Trees Planted	Trees Removed
1 year (2022)	161	131
5 years (2018 - 2022)	923	338

The University maintains its tree database and takes the opportunity to periodically notify the City of Seattle of changes in the University's urban forest. A report to the City is not requried under the 2019 University of Washington Seattle Campus Master Plan, but one was provided in 2022 to share information and foster dialogue. The report included the table above with tree planting and removal metrics, as well as GIS maps (sample included below).



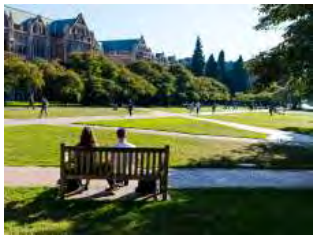
Tree Planting Mosaic

The landscape of the UW Seattle campus can be categorized in a framework of tree planting mosaic types. Each type has distinct growing conditions that influence which tree species can thrive in each piece of the mosaic. The spatial qualities of each area have different characters and functions including, the highly figured "campus green" spaces of Denny Yard and Rainier Vista, the "woodland groves" of north campus housing, and the hardscaped plazas and terraces across campus. The spatial qualities of these spaces give context to the social dimension of tree species selection for plantings. By identifying and describing both the geophysical and social aspects of each mosaic type, the tree planting mosaic emphasizes each element while also addressing adjacent relationships and the integrated whole. The reading of the campus as a mosaic celebrates the richness and diversity of trees types, and resists the temptation to find campus-wide solutions to issues that demand more nuance. Strategic urban forestry practices can help emphasize the character of each tile within the mosaic while enhancing ecological and social function campus-wide.

Tree Planting Mosaic Typologies

WOODLAND GROVE

The woodland grove is the immediately recognizable Pacific Northwest frame for the university, with a mixture of tall evergreens and deciduous trees, and a robust canopy. The soil is rich in organic matter as leaf debris is allowed to accumulate. Dense tree plantings and canopy are encouraged in these groves. The continuity of the woodland grove around three sides of central campus is key to the campus character.



CAMPUS GREEN

Campus greens are clearly figured landscapes, and amongst the most well known parts of the campus. They are often bounded by architecture or by woodland plantings. They have either open lawns, or lawn beneath a shading canopy, providing space for studying, casual sports, and informal gatherings. The soil is well-drained but may be less pruductive due to the presence of managed lawns.

PLAZAS / COURTYARD / TERRACES / URBAN FRONTAGE

These are areas near or around buildings or part of building entry sequences. They are dominated by hardscape, even when the spaces themselves can range in quality from gardeneque to passageways to large open spaces. The quantity of soil for trees to grow in is limited in these areas, especially urban frontage where trees are often planted in pits between the street and the sidewalk. The hardness of these areas benefit from the soft qualities of trees and make them more hospitable.

WETLAND / WATERFRONT

Wetlands and Waterfronts includes structured and unstructured shoreline access. The soils in these areas are moist or wet much of the year which limits which tree species can survive in these landscapes. This type of landscape provides unique habitat on campus and is also valued for recreation, passage, and research..

MEADOW / GARDEN

The UW's meadows are large swaths of unmowed grasses with informal clusters of trees sparsely scattered throughout. The UW's farm and garden spaces are areas for cultivation that use low-till or no-till planting practices. The soil in these areas is relatively nutrient rich due to low disturbance of meadows and fertilization of crops. The vast expanse of this system makes it a very visible part of the University's natural habitat.

Campus Neighborhoods

WEST | SOUTH | CENTRAL | EAST

The University of Washington Seattle campus is made up of four distinct neighborhoods, each contain unique functions and qualities grounded in their academic context. Each zone has clearly defined boundaries that are delineated by steep slopes and major roadways creating strong edges between each neighborhood. This has lead to a campus that has a tremendous range of experiences while also suffering from being disconnected in places. Central Campus is the quintessential university experience, consisting of iconic landscapes and architecture. South Campus is predominately covered by the UW Medical Center and Health Science facilities that largely obstruct waterfront access. West Campus has access to the waters' edge at Fritz Hedges Waterway Park, a new iconic amenity that facilitates the open space needs for adjacent campus housing. East Campus is home to collegiate athletics and recreation paired with large parking lots. As unique pieces of the whole, each neighborhood should be integrated into a seamless mesh that is variable yet cohesive.

With each neighborhood having their own unique condition, they require specific goals and strategies based on their nuanced character, function, and land use. Analyzing each neighborhood as a whole and then zooming into specific conditions, a strategy will be established that works to identify opportunities and challenges for increasing the canopy cover that emphasizes the neighborhoods primary function. By understanding the relationship between canopy cover, landscaped and hardscaped areas, a canopy goal can be proposed based on the available areas of landscape and hardscape that exist while recognizing the programmatic needs of each neighborhood. The neighborhood goals paired with campus wide goals will provide a multi-grain understanding of the campus's urban forestry condition along with opportunities for enhancing the experience of the campus by improving its urban forest resource.

Central Campus

West Campus

East Campus

South Campus

NEIGHBORHOOD SNAPSHOT

West Campus

Total Area : **69 acres** (12% of campus)
Landscape Area : **15 acres** (22% of neighborhood)
Tree Canopy : **12 acres** (17% of neighborhood)
# of Trees : **1,333** (15% of inventoried trees)

South Campus

Total Area : **57 acres** (10% of campus)
Landscape Area : **15 acres** (26% of neighborhood)
Tree Canopy : **9 acres** (16% of neighborhood)
# of Trees : **736** (8% of inventoried trees)

Central Campus

Total Area : **215 acres** (36% of campus)
Landscape Area : **89 acres (**41% of neighborhood)
Tree Canopy : **78 acres** (36% of neighborhood)
# of Trees : **5,113** (56% of inventoried trees)

East Campus

Total Area : **173 acres** (29% of campus)
Landscape Area : **69 acres** (40% of neighborhood)
Tree Canopy : **22 acres** (13% of neighborhood)
# of Trees : **1,723** (19% of inventoried trees)

Union Bay Natural Area: 83 acres (13% of campus)

Total Campus Land Area: 597 acres (100%)

Neighborhood Canopy Goals

Proper and strategic tree selection is vital when working towards a specific canopy goal. Each tree has its own dimensions that reflect the overall shape of the tree from pyramidal to columnar. Choosing trees that have a wide mature canopy width can greatly reduce the number of trees needed to achieve canopy goals for each campus neighborhood and the campus overall. Canopy goals for each of the campus neighborhoods were derived by comparing the results of a generic canopy analysis (below) with the available land in each campus neighborhood for new plantings. Integrating this type of thinking into design projects could help grow the University's urban forest for years to come.

GENERIC TREE ANALYSIS

Canopy Width (ft)	Area per tree (sq ft)	# of trees per acre
5	*20*	*2,218*
10	*79*	*555*
15	*177*	*246*
20	*314*	*139*
25	*491*	*89*
30	*707*	*62*
35	*962*	*45*
40	*1,257*	*35*
45	*1,590*	*27*
50	*1,963*	*22*
55	*2,376*	*18*
60	*2,827*	*15*
65	*3,318*	*13*
70	*3,848*	*11*
75	*4,418*	*10*

Metasequoia glyptostrobodies **20'**

Circidiphyllum japonicum **40'**

Paulownia tomentosa **50'**

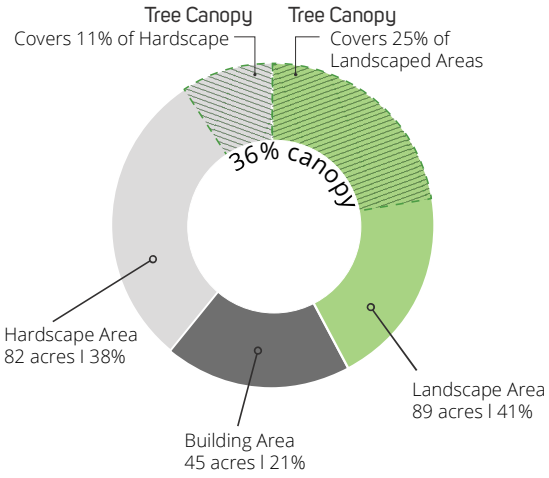
Juglans nigra **70'**

Central Campus

215 ACRES | 5113 TREES (56%) | 378 SPECIES

Central Campus is the point of origin for most people visiting the University of Washington Seattle Campus. It has clearly defined landscapes, ranging in size and importance from the Rainier Vista to Memorial Way. This neighborhood is vibrant with high levels of social life, activities, and diversity of students, staff, and faculty. Central Campus is highly developed with limited space for future development that highlights a need to preserve and enhance the urban forest for its environment, social, and education values. The urban forest can be leveraged to reduce energy cost in buildings, assist with wayfinding, and as a cultural history tour. The balancing of vegetation and building has been well established in this neighborhood with 40% of the ground plane dedicated to landscaped areas. It is recommended to maintain this condition as central campus evolves to meet new demands as an effort to preserve the beloved natural quality possessed by UW.

LAND USE BREAKDOWN



Tree Canopy
78 acres | 36 % cover

Building Area
45 acres | 21 %

Landscape Area
89 acres | 41 %

Hardscape Area
82 acres | 38 %

FORMAL LANDSCAPES ON CENTRAL CAMPUS

The campus greens of Central Campus are designed and managed as the landscape legacies of the University. The formal layout of the campus quadrangle provides the setting for the collegiate gothic architecture of surrounding buildings and is a landscape counterpart to plazas, such as Red Square.

The language of these landscapes describes the University as a prestigious place for study and research. The ratio of open lawn to tree canopy should be regulated to maintain the sense of grandeur that has been familiar to generations of students.

CAMPUS GREENS (LAWNS)
& Landscape Features

CANOPY COVER OVER LANDSCAPING

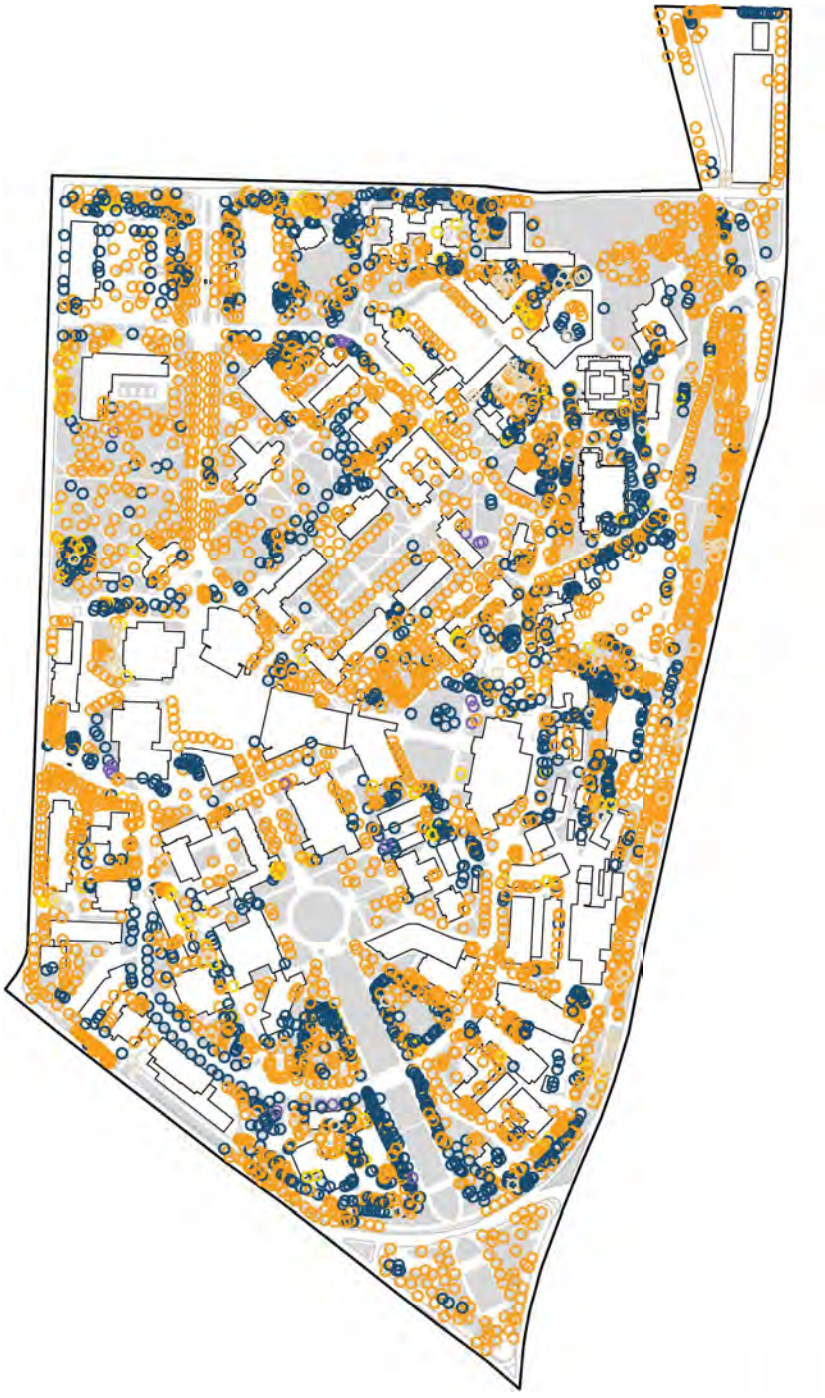
Landscape Type	Total	% Not Covered
Lawn	24 acres	64%
Planter Bed	24 acres	50%

Map adapted from page 43 of the 2019 Campus Master Plan

TREE TYPE

The diversity and density of tree species in Central Campus transforms areas of this neighborhood into nature walks, providing respite from the hectic urban condition, and supports play in the open lawns. The greatest diversity of tree types occurs at the edges of campus where a large volume of future development is planned. Central campus also consists of memorial and iconic landscapes like Memorial Way and the Quad that needed to be protected and preserved. Increasing the diversity of trees while protecting existing trees during construction can help maintain and grow the living lab of trees in Central Campus.

Central Campus makes up a little over 40% of the University's total land area with more than half of the total number of trees. The canopy consists of 62% deciduous and 32.5% conifer trees with approximately 37% of the total being native. With a canopy cover of 37% Central Campus has the fullest canopy with the highest density of trees on campus.



Tree Type	Total	% of Total
Deciduous	3,181	62%
Coniferous	1,662	32.5%
Broadleaf Evergreen	146	3%
Deciduous Conifer	23	0.5%
Unknown	101	2%

LAWNS

The University has a number of large open lawns with cross-axial paths that speak to the history and evolution of the campus. In some cases, existing trees are aligned along historic paths that no-longer exist giving the trees a random order. Trees play a role as edges, enclosing space, and landmarks. Maintaining the function of the space while providing substantial canopy cover could help organize the lawns into smaller defined spaces with varying micro-climates. Increasing canopy cover needs to be balanced with preserving open lawn for large group events.

DEVELOPMENT

The landscaped areas adjacent to existing surface parking lots and along the edges of Central Campus consist of the densest and maturest groves on campus. These areas are also the most ideal for development because of their current under-utilization and the lack of developable land. Creative site planning and architectural form making can help protect the mature trees in these areas. Along with protecting existing trees, projects have the opportunity to add to the canopy while gaining the cooling and heating savings.

IRRIGATION

Irrigation is a critical component for establishing new trees on campus. Not all landscaped areas in Central Campus have automatic irrigation system which limits the University's ability to add new vegetation in these areas. Integrating new irrigation systems into the landscape with new development can help expand the areas where additional canopy can be added. Mapping the landscapes that currently lack irrigation in Central Campus will help focus efforts to these areas.

BARRIERS TO NEW PLANTINGS

Irrigation is a critical component for establishing new trees on campus. Not all landscaped areas in Central Campus have automatic irrigation system which limits the University's ability to add new trees in these areas.

Development is also of concern. Few areas are available for building other than sites that include lawn and mature trees. Many of the remaining landscapes are iconic to the University and deserve to be maintained as open space with the potential of adding additional trees.

Irrigation should be installed as renovation and new development projects are implemented. Recent construction has included irrigation improvements or added irrigation where it did not exist prior. Examples of projects that included irrigation work include, the Denny Hall renovation, the new Burke Museum, North Campus Housing and Denny Field, the Intellectual House, West Campus Housing, Founders Hall, the Health Sciences Education Building, and the Hans Rosling Center for Population Health. All future projects should include irrigation work to increase the viability of new tree plantings.

The complexity of Central Campus offers a great opportunity for urban forestry research associated with development and wildlife habitat. Another opportunity with potential to involve students is finishing surveying trees within Kincaid Ravine and along the Burke Gilman trail.

The University has worked on opportunities to preserve the canopy on Central Campus. The grounds were reviewed to prioritize landscapes for improvement and create criteria for valuing which aspects should be preserved. A tree replacement policy was implemented to achieve no net tree canopy loss (see *Design Guidelines & Standards* section).

IRRIGATION MAP KEY

- Automated Irrigation
- No Irrigation
- Buildings and Hardscape

OPPORTUNITIES FOR TREE TREE PLANTING

Areas for new trees plantings on Central Campus are sparse. The map (right) identifies tree planting opportunities by overlaying automatic irrigation in planting areas, canopy gaps, and iconic landscapes. This analysis resulted in the areas outlined in orange where new trees could be planted.

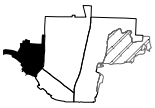
Other opportunity zones include mature tree replacement plantings. The University is already planning for the replacement of trees nearing end-of-life on Parrington Lawn and in other iconic landscapes. By establishing new trees in the understory years before mature tree removal, the University is working to preserve the aesthetic quality of those landscapes and provide seemless experiences across class years.

While most opportunity areas on Central Campus require thoughtful tree species selection and attention during the first 2-3 years, Kincaid Ravine could be seeded periodically and allowed to grow naturally.

MAP KEY

- Tree Planting Opportunity Areas
- Automated Irrigation
- Landscaping With No Irrigation
- 2021 Canopy

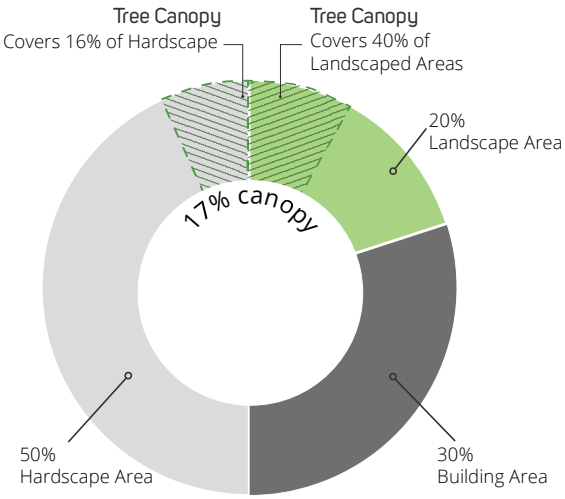
West Campus

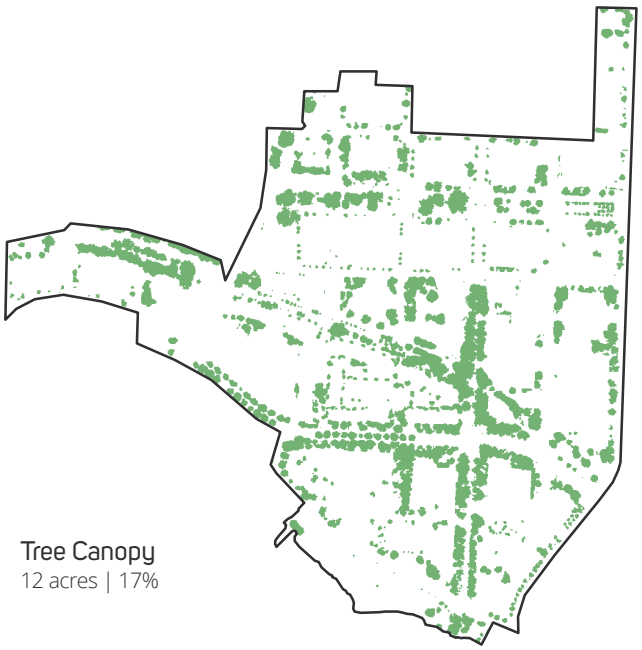


69 ACRES | 1,333 TREES | 170 SPECIES

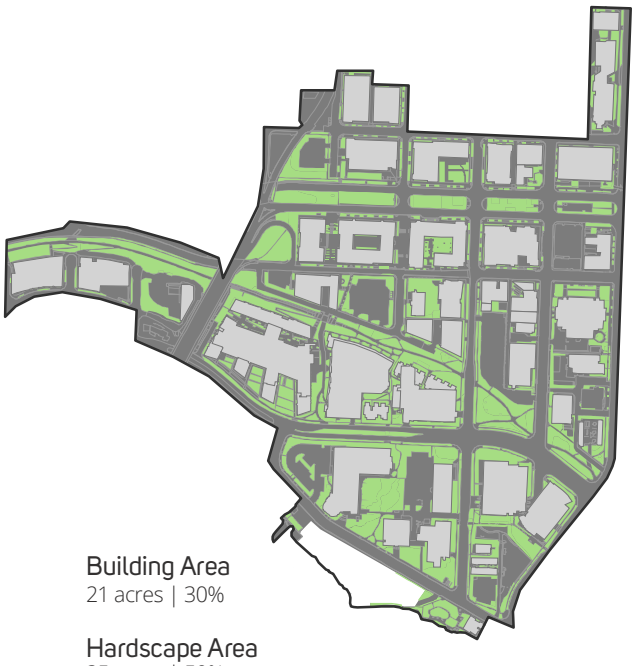
West Campus is characterized by it being integrated into the urban fabric of the University District giving it an active urban edge with the primary land uses being shared between student housing and educational facilities. The scale of buildings range from one to six stories, with taller proposed in the 2019 Campus Master Plan. West Campus is spotted with small semi-public courtyards and terraces that are part of the architecture. Trees line streets, buffer buildings from the sidewalk, and edge pathways. The streetscape and design of buildings plays the biggest role in establishing a complex forest canopy in this zone, but is challenging due to varying existing conditions that are not ideal for new plantings. The Campus Parkway median offers an opportunity for increased canopy coverage and encourage people along the boulevard, through the urban edge, and into campus.

LAND USE BREAKDOWN





Tree Canopy
12 acres | 17%



Building Area
21 acres | 30%

Hardscape Area
35 acres | 50%

Landscape Area
14 acres | 20%

TREE TYPE

This area of campus is highly urban. Yet, West Campus has a high diversity of tree species with 170 unique varieties. A large amount of development occured in West Campus between 2006 to 2010, so many of the trees within this neighborhood are young and have not reached their full potential to provide ecological services, such as carbon sequestration. Narrow planters and compacted soil may impact tree health or growth rates. Coniferous trees are scattered across west campus in low densities with the majority being along the Burke Gilman Trail. Deciduous trees are most commonly sited directly in front of building facades.

Tree Type	Total	% of Total
Deciduous	1,107	83%
Coniferous	160	12%
Broadleaf Evergreen	31	2%
Deciduous Conifer	9	1%
Unknown	27	2%

STREET CANOPY

West Campus is defined by its urban interface. It is the only campus area to be integrated into the Seattle street grid. As such, it often lacks space for trees between streets and buildings. The varying canopy condition in West Campus can be experienced through dramatic changes in micro-climates between areas with and without canopy. An additional challenge beyond having enough space for trees to thrive, is the careful negotiation between trees and below and above-grade utility infrastructure.

WEST CAMPUS HOUSING

A large percentage of West Campus is dedicated to student housing. Each residence hall provides semi-public courtyard spaces integrated into the architecture. Within these courtyard spaces, trees should be leveraged to provide pleasing environments that bleed from the outside-in and vice versa.

WATERFRONT

The West Campus waterfront is evolving to provide greater public access and improve the environmental quality of the shoreline. The West Campus Green, a proposed campus landscape asset, is expected to enhance the connection from campus to the waterfront at Fritz Hedges Park. This new land use would provide vistas of the water and be a new space for the campus community and the greater public to recreate, research, and convene in a beautiful setting.

PLANTING OPPORTUNITIES: LANDSCAPED AREAS

Landscaped areas with no canopy cover provide lower cost opportunities to plant trees.

CANOPY COVER OVER LANDSCAPING

Landscape Type	Total	% Not Covered
Lawn	4 acres	75%
Planter Bed	8 acres	63%

PLANTING OPPORTUNITIES: HARDSCAPED AREAS

Hardscaped areas with no canopy cover should be analyzed to determine opportunities to convert little-used impervious surfaces to tree planters.

CANOPY COVER OVER HARDSCAPE

Hardscape Type	Total	% Not Covered
Parking Lots	5 acres	96%
Pedestrian Paths	9 acres	78%

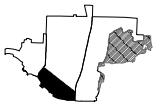
ISSUES & OPPORTUNITIES

The density of buildings within the existing urban grid makes finding places to add trees challenging. As new development occurs building footprints should be designed to preserve existing trees while providing additional space for new landscapes. Identifying gaps within the existing urban forest along street edges can be areas of focus for increasing the diversity of trees in West Campus. With a park along the waterfront, there are opportunities to enhance the water's edge for salmon and other wildlife while growing the forest canopy cover. With 10 acres of landscape and 5 acres of parking without canopy cover, there is an opportunity for increasing tree canopy cover.

ACTION ITEMS

- Prioritize Campus Parkway's median as a future design project that adds both public space and canopy cover to the space.
- Work with the city on enhancing the environmental performance of the streetscape.
- Use trees along proposed green streets to connect West, Central and South Campus to the waterfront and to one another.
- Build upon the implementation of Fritz Hedges Waterway Park and the 2019 Campus Master Plan with West Campus development sites to enhance the ecological and social funtion of the shoreline.

South Campus

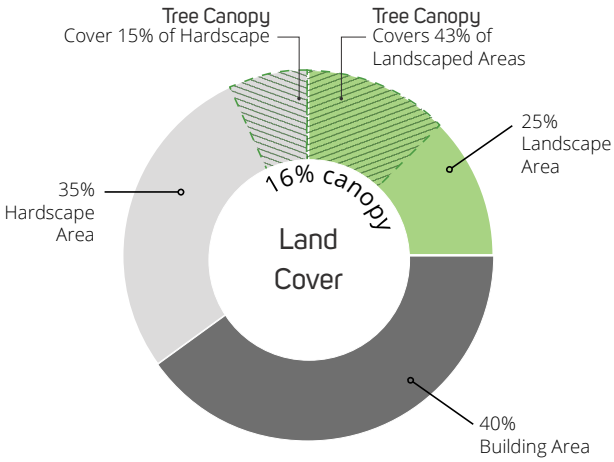


57 ACRES | 736 TREES | 107 SPECIES

South Campus is dominated by health sciences facilities, with the UW Medical Center being the major landmark in this neighborhood. The large footprint of the hospital and parking lots limits the available area where new trees can be planted. With plans to establish new landscapes along the Portage Bay Vista, there is an opportunity to increase the health and size of canopy cover in South Campus. Recognizing the limited amount of ground floor space and the visual benefits associated with trees, the University has installed green roofs atop existing facilities in this neighborhood. The density of land uses makes establishing a robust, continuous tree canopy challenging.

South Campus currently has the second lowest amount of canopy cover of all four campus neighborhoods. This could be due to South Campus having the largest percentage of land area dedicated to buildings on campus .

LAND USE BREAKDOWN



Tree Canopy
9 acres | 16%

Building Area
23 acres | 40%

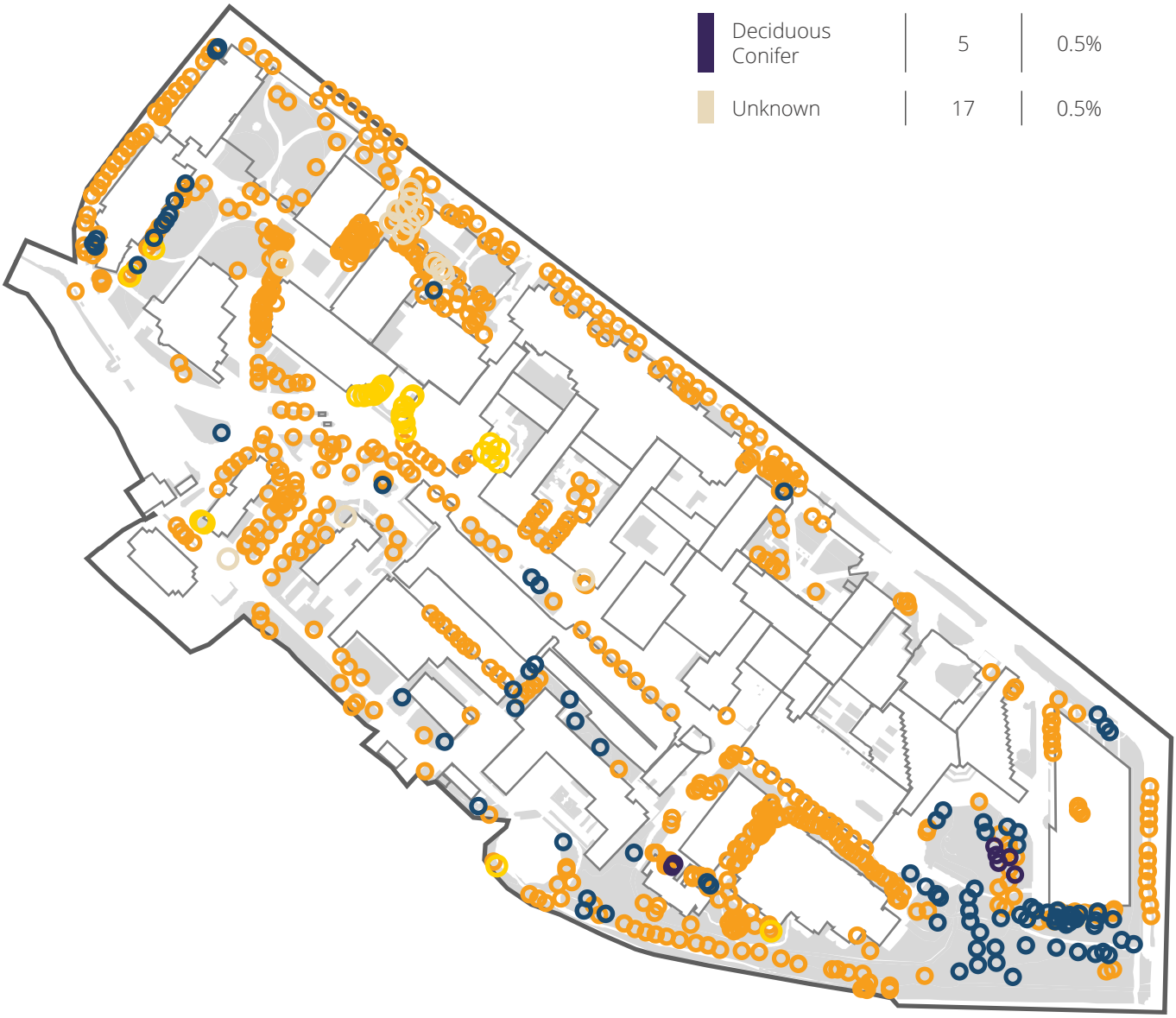
Landscape Area
14 acres | 25%

Hardscape Area
20 acres | 35%

TREE TYPE

With more than a 1:6 ratio between coniferous and deciduous trees, South Campus has the least diversity of tree species. The majority of coniferous trees are located along building facades and the waterfront. There is a need to better understand the growing conditions that exist within these areas to develop strategies for improving species selection, maintenance, and tree health.

Tree Type	Total	% of Total
Deciduous	597	81%
Coniferous	90	12%
Broadleaf Evergreen	27	3.5%
Deciduous Conifer	5	0.5%
Unknown	17	0.5%



UW MEDICAL CENTER/HEALTH SCIENCES

Health Sciences and the UW Medical Center occupy the majority of land in South Campus, limiting the amount of space for surface level landscapes. The UW Medical Center has utilized some of its roof surface for landscaping which could be expanded to more areas. Providing a view of nature from patients' rooms and offering vegetated spaces for reflection and respite could aid with patient recovery while enhancing the canopy cover in South Campus.

WATERFRONT

The waterfront in south campus has two primary conditions; remnants of the historic UW golf course and an industrial edge, all of which provide a harsh transition from the land to the water. The industrial edge has little to no vegetation and does not offer opportunities for the public to access the waters edge. The vegetated areas consist of large open lawns with allees of trees that once lined the fairways of the University Golf Course until 1947 when it was replaced by the UW School of Medicine.

COURTYARDS & VISTA

In order to provide open outdoor space for the public in South Campus, courtyards have been integrated into the architecture to provide additional outdoor vegetated spaces. The function and use of courtyards varies between primary entrances, places for refuge, and visual beauty. Each condition requires different design considerations, but can all benefit from having additional trees planted of varying species to increase the volume, color, and shade within an environment dominated by concrete, steel, asphalt, and brick.

PLANTING OPPORTUNITIES: LANDSCAPED AREAS

Landscaped areas with no canopy cover provide lower cost opportunities to plant trees. The University would like to increase canopy in South Campus to improve pedestrian circulation while also maintaining views to Portage Bay.

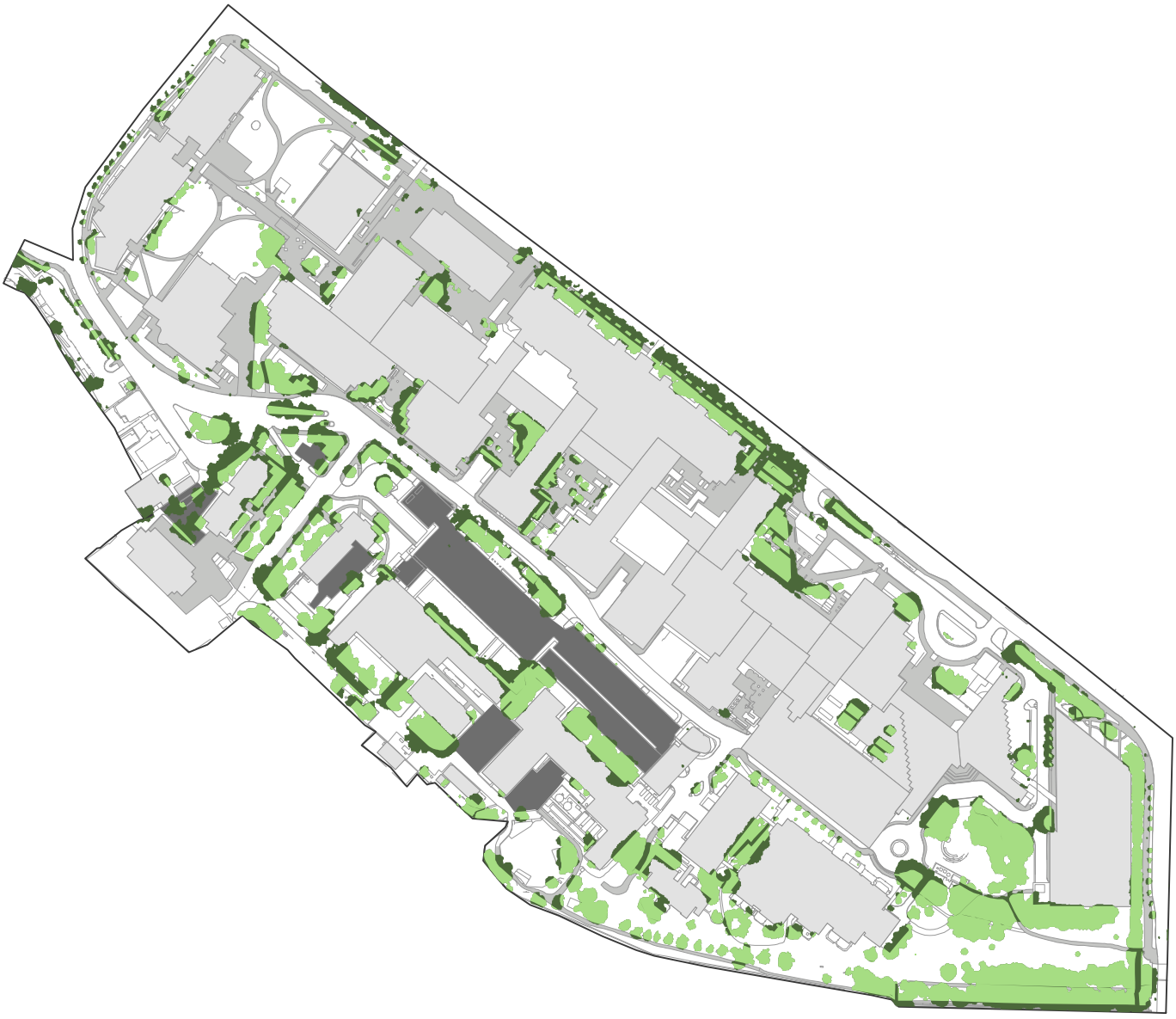
CANOPY COVER OVER LANDSCAPING

Landscape Type	Total	% Not Covered
Lawn	6 acres	75%
Planter Bed	7 acres	57%

- Tree Planting Opportunity Areas
- Canopy Cover
- Landscaped Areas - No Cover
- Buildings

PLANTING OPPORTUNITIES: HARDSCAPED AREAS

Hardscaped areas with no canopy cover should be analyzed to determine opportunities to convert little-used impervious surfaces to tree planters.



CANOPY COVER OVER HARDSCAPE

Hardscape Type	Total	% Not Covered
Parking Lots	3 acres	66%
Pedestrian Paths	7 acres	85%

- Parking Lots
- Pedestrian Paths
- Buildings
- Landscape Canopy Cover
- Hardscape Canopy Cover

ISSUES & OPPORTUNITIES

South Campus makes up 10% of the campus's total land area, while having 8% of the total trees. This campus neighborhood is highly developed so there needs to be a strategy for improving growing conditions for trees. About 75% of the lawn in South Campus is not covered by tree canopy which leaves approximately 7 acres of opportunity area to plant trees in irrigated landscape. The 2019 Campus Master Plan goal of redeveloping South Campus with taller buildings and more pathways between Pacific Street, the waterfront, and a South Campus Green will provide more planting opportunity.

ACTION ITEMS

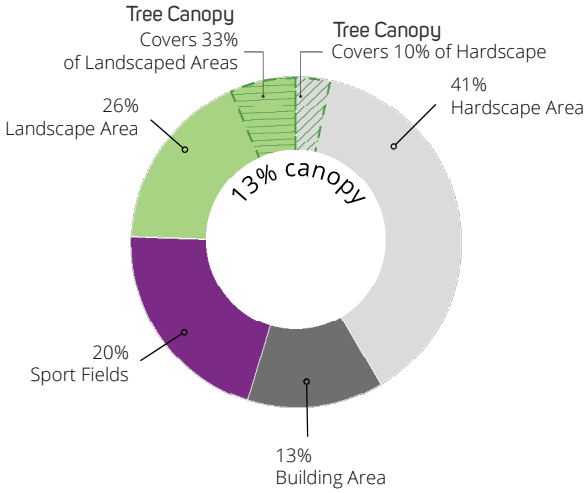
- Develop green infrastructure standards that emphasize green roofs for new development across campus.
- Create a shoreline restoration plan that protects the shoreline and enhances aquatic habitat for endangered salmon species.
- Celebrate the historic conditions that exist along the waterfront with enhanced open space and strategic water access consistent with the 2019 Campus Master Plan.
- Establish a focused management plan for improving tree condition.
- Emphasize landscaped courtyard development within large buildings to create healing and therapeutic spaces.
- Maximize trees within Portage Bay Vista while preserving view.

East Campus

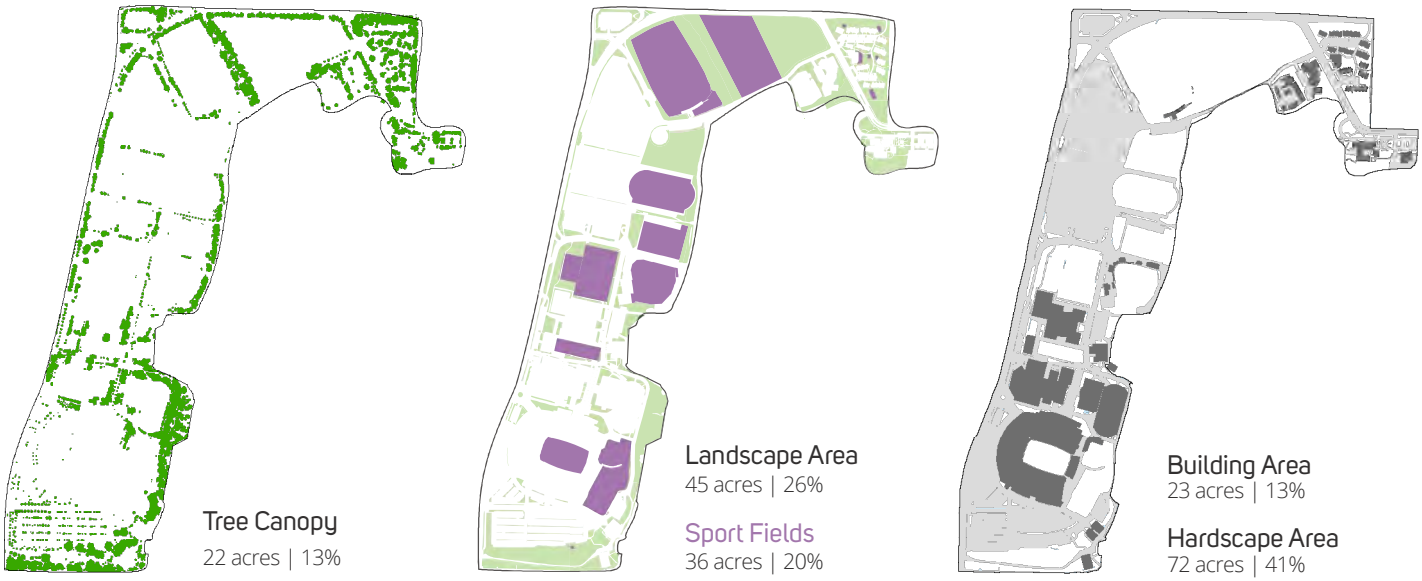
173 ACRES | 1,723 TREES | 191 SPECIES

East Campus is home to the University's storied collegiate athletics program. The athletic village includes sports fields, gyms, and stadiums. These facilities are surrounded by a sea of surface parking lots that are designed to meet the capacity of major sporting and ceremonial events. As public transportation systems and bike routes evolve, some of these spaces may not be needed in the future. East campus also consists of family-student housing and additional campus facilities along its Eastern edge, making a pedestrian friendly environment between Central Campus and these areas important. Additionally, pedestrian connections are needed to Union Bay Natural Area which is not included in this analysis because it has yet to be surveyed and is not managed by the University of Washington's Grounds staff, but offers valuable ecological, educational, and cultural benefits to the University.

LAND USE BREAKDOWN

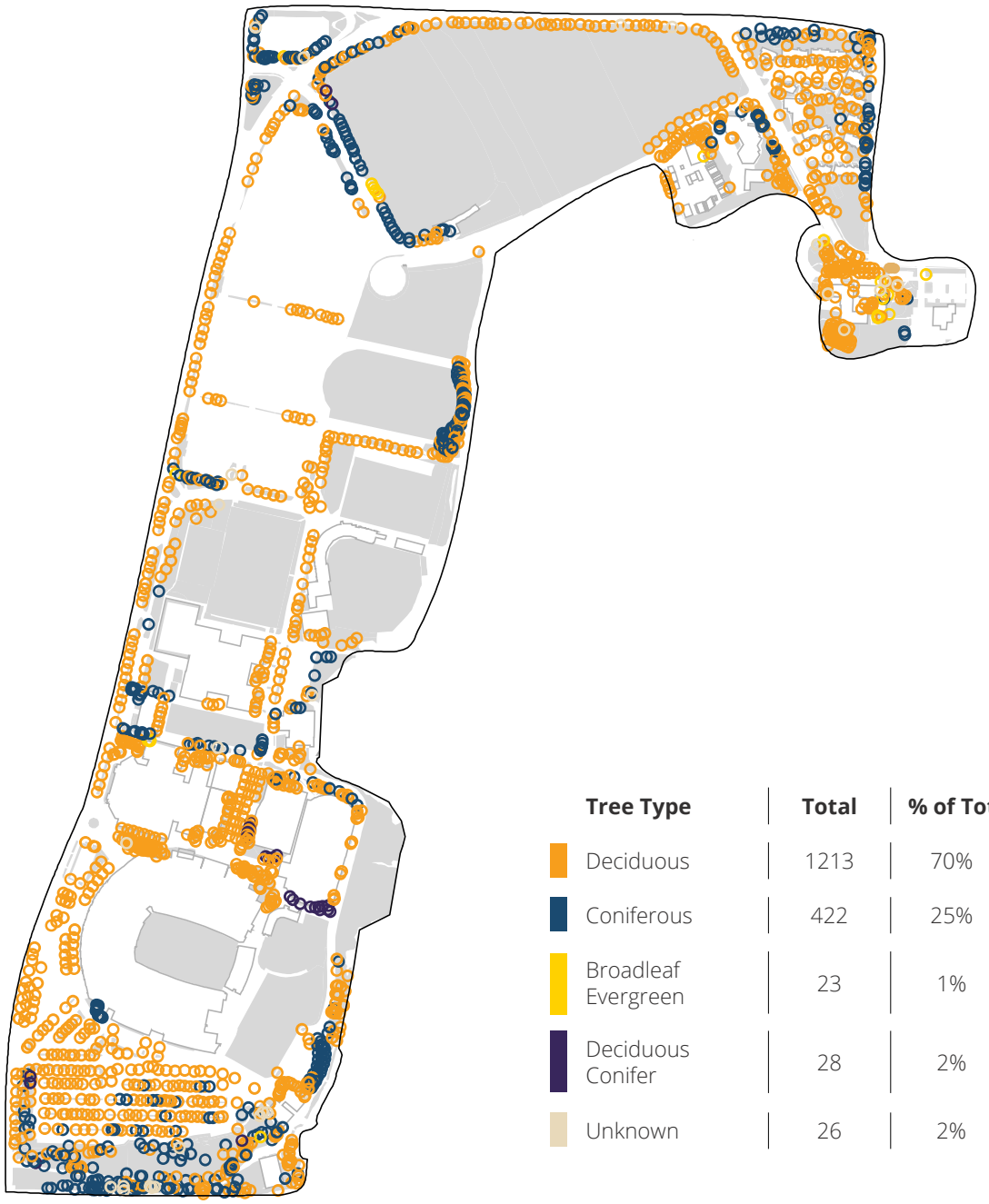


East Campus has the lowest canopy cover percentage out of the four neighborhoods due the large volume of hardscape, buildings, and sports fields. With only 10% of the hardscape covered by canopy, additional plantings would be welcomed in these areas. The parking area behind HEC Edmundson Pavilion provides an example to how trees can be integrated into the landscape without reducing the number of parking stalls.

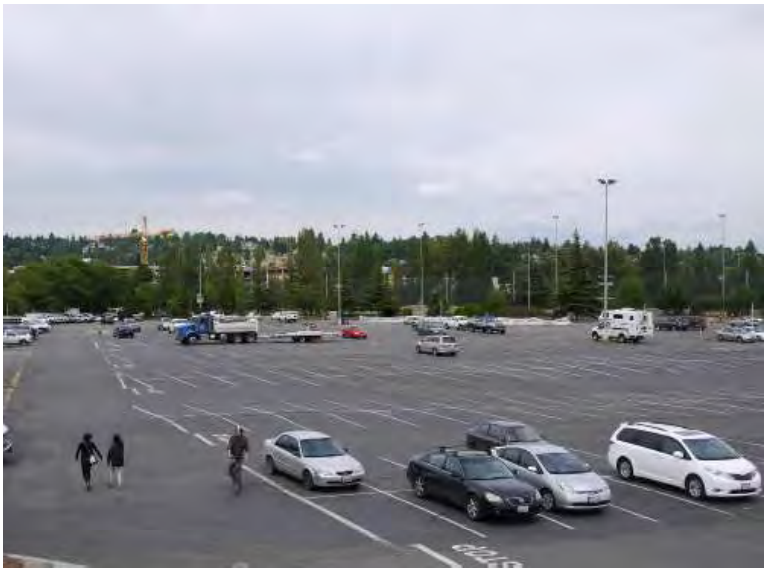


TREE TYPE

East Campus's canopy consist of 70% deciduous trees with 20% of the total trees being native. Within the existing landscaped areas there are large open areas where trees could be added. One challenge to increasing canopy cover in this neighborhood is the conflict between trees, sport fields, parking stalls, and vehicular circulation which are paramount to the function of East Campus. With this neighborhood also having access to the water, its edges could be greatly improved by softening them with additional plantings. Other challenges to growing canopy in this neighborhood is the historic landfill debris and beavers. Once category for species for new tree plantings should be the depth of the roots at maturity. Species with shallow roots that will not penetrate the clay cap over the landfill are desirable. Beavers have been active in taking down trees along Ravenna Creek and the Union Bay shoreline. Beaver diet should also be considered in species selection.



Tree Type	Total	% of Total
Deciduous	1213	70%
Coniferous	422	25%
Broadleaf Evergreen	23	1%
Deciduous Conifer	28	2%
Unknown	26	2%



HARDSCAPE

The vast quantity of surface level paving in East Campus creates a harsh micro-climate throughout the year. Placing trees within this landscape would be a benefit to the pedestrian experience. However, the opportunities to establish trees are slim due to limited soil depth, lack of irrigation, and the heat affect of the asphalt. Many trees in these parking lot planters have failed and have not been replaced due to the difficulty of keeping trees healthy. Instead, the University wants to test the viability of solar canopies to provide shade and electricity.

SPORT FIELDS

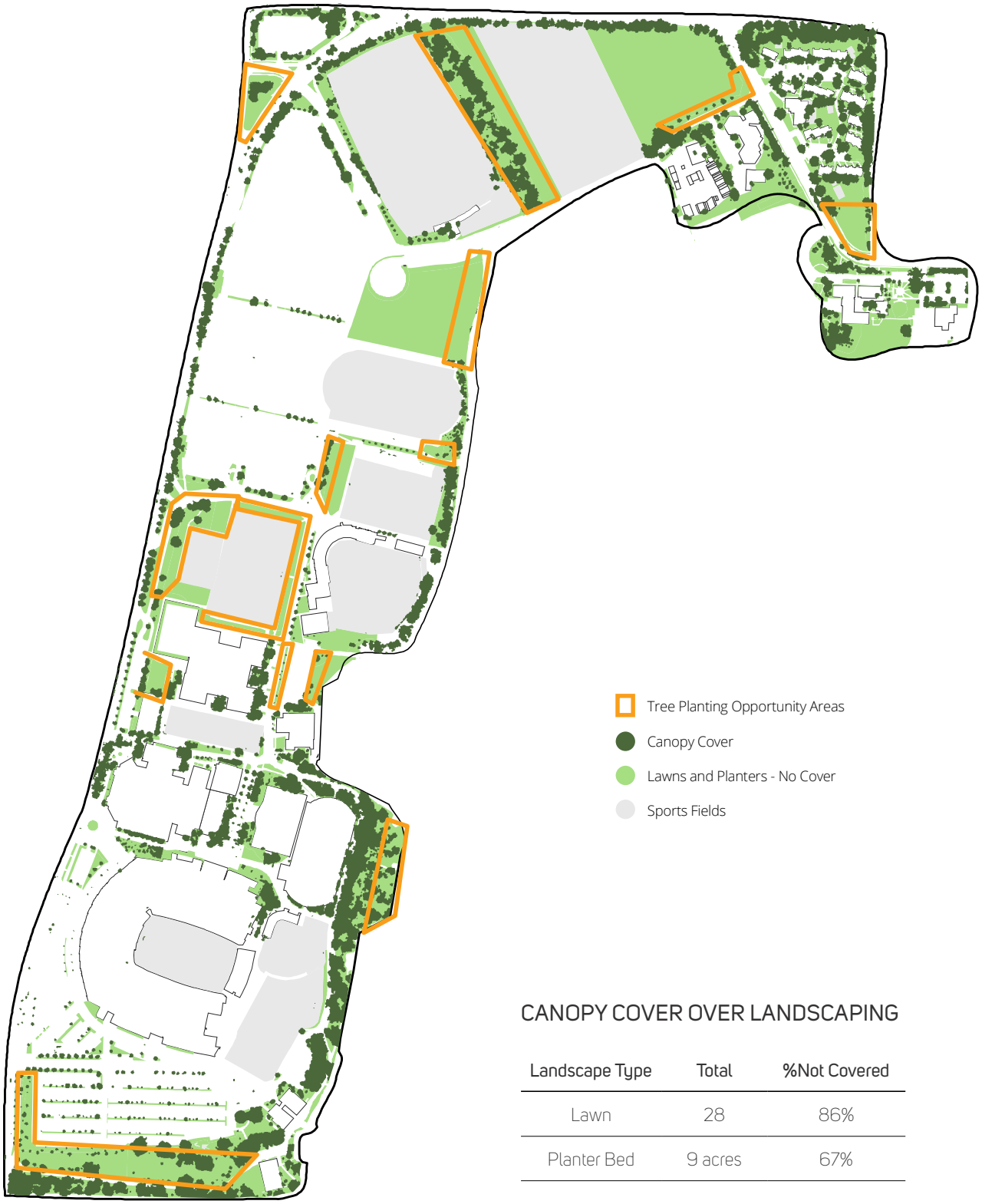
Collegiate athletics are a critical part of the University of Washington's legacy. They require a broad open space for each sporting activity, seating, and operational needs. The requirements of these facilities prohibits the siting of trees within stadiums, courts, or fields. However, trees could be utilized around each facility, especially UW Recreation fields, to help block the wind and sun providing a more pleasant environment for viewers and participants.

HISTORIC LANDFILL

Historically, this area was used as a municipal landfill that was closed and capped in 1971. Drainage and settlement issues can be seen while walking through East Campus, making the addition of trees complex. Today, a Montlake Landfill Project Guide has been developed to define what is possible in the landfill area by defining allowable maintenance and construction activities. Although the constraints on this page limit tree plantings, creative solutions can be found to create a healthier landscape.

PLANTING OPPORTUNITIES: LANDSCAPED AREAS

Landscaped areas with no canopy cover provide lower cost opportunities to plant trees.

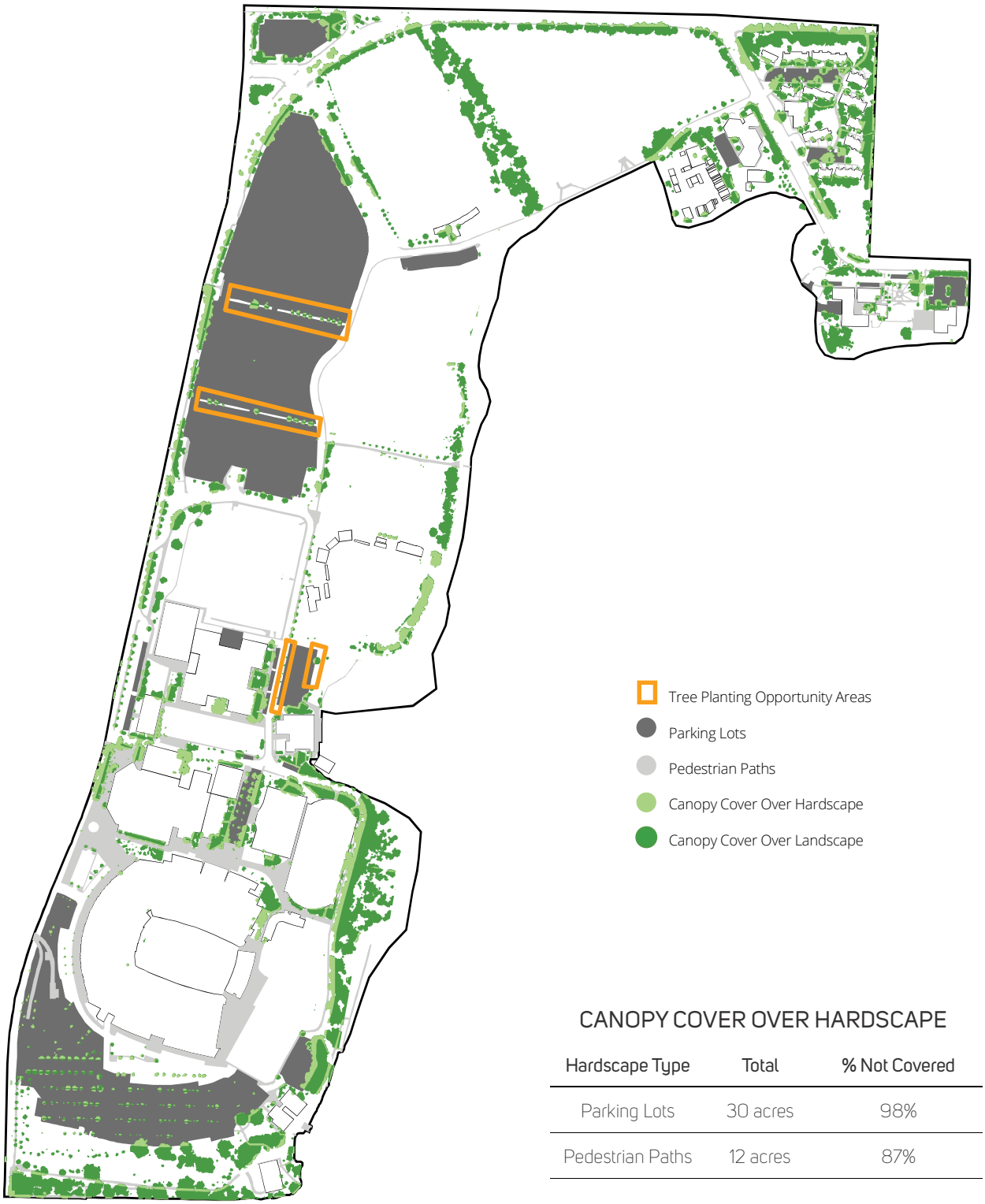


CANOPY COVER OVER LANDSCAPING

Landscape Type	Total	%Not Covered
Lawn	28	86%
Planter Bed	9 acres	67%

PLANTING OPPORTUNITIES: HARDSCAPED AREAS

Hardscaped areas with no canopy cover should be analyzed to determine opportunities to convert little-used impervious surfaces to tree planters.



CANOPY COVER OVER HARDSCAPE

Hardscape Type	Total	% Not Covered
Parking Lots	30 acres	98%
Pedestrian Paths	12 acres	87%

ISSUES & OPPORTUNITIES

Integrating trees into parking lots and around sport fields provides the best opportunity for increasing canopy cover in East Campus considering that 90% of the hardscape has no canopy cover. Strategic tree plantings could help connect East Campus to adjacent neighborhoods by highlighting points of access and street crossings. Montlake Boulevard is a strong barrier to campus that could also benefit from additional tree plantings and widening the sidewalk. The additional challenge of historic landfill debris under much of the ground plane restricts new development and tree planting. With the predominate use being athletics and recreation, there needs to be strategies developed for how to maximize canopy cover associated with these land uses.

ACTION ITEMS

- Explore creative strategies for increasing tree canopy cover in and around stadiums and parking lots.
- Work with the Center for Urban Horticulture (CUH) to establish a research focus in Urban Forestry practices.
- Use trees as a wayfinding tool to promote a more seemless pedestrian connection between Union Bay Natural Area (UBNA), University Village, the Sound Transit light rail station, CUH, the stadiums, and Central Campus.
- Utilize the historic landfill condition as an opportunity for research associated with adding and maintaining landscape in this unique environment,
- Complete a tree survey of the UBNA.


3

UW's Urban Forest

Man is nature as much as the trees.

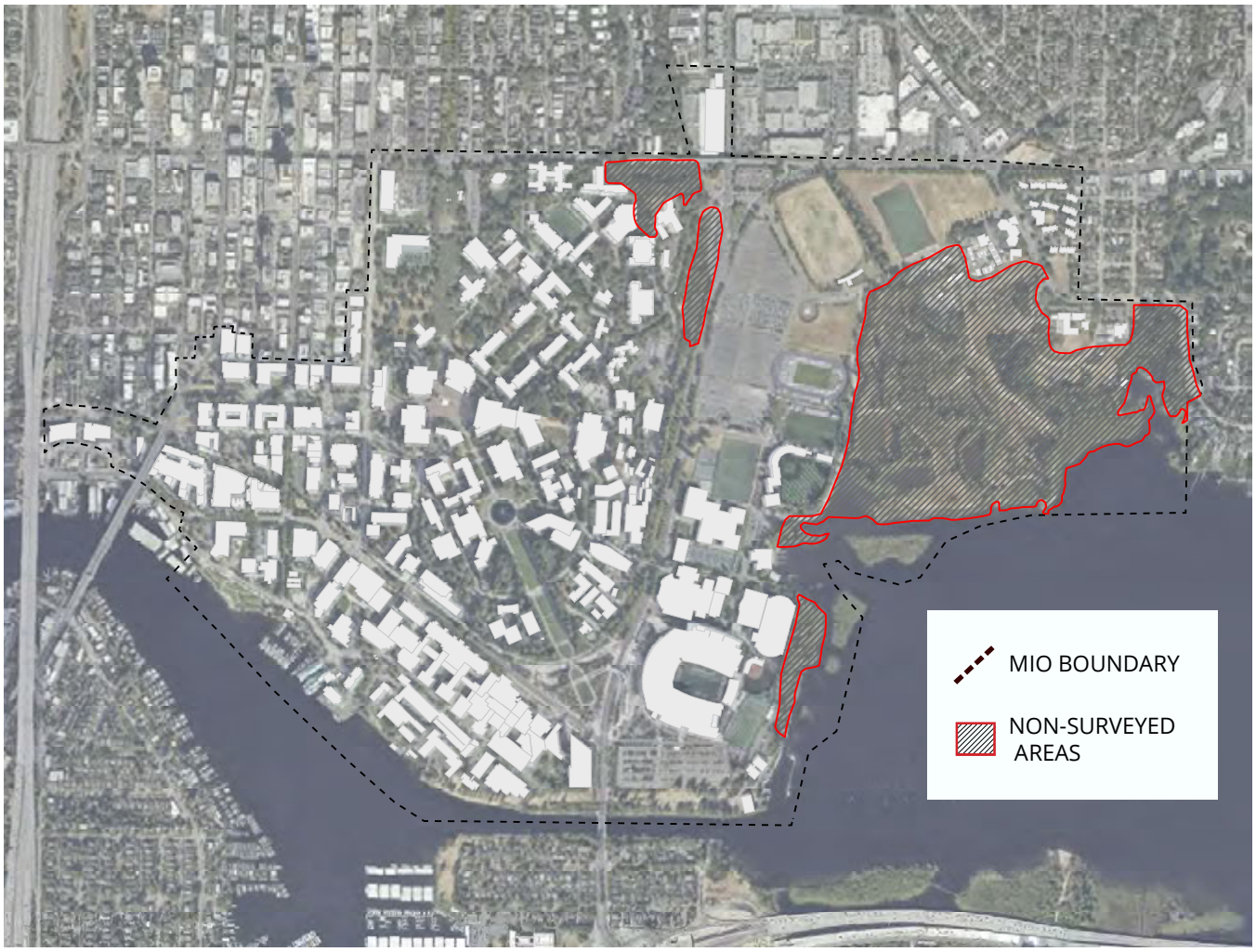
Daniel Urban Kiley

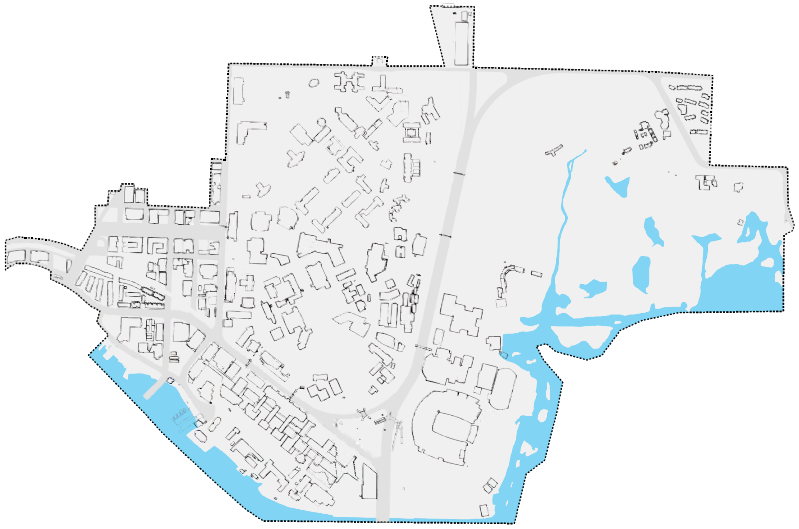
The University of Washington was carved out of a forest of trees, where remnants of its grandeur still exist today at the edges of central campus. Framed by water and hills, the University consists of a range of landscape types, each providing important environmental services that as a whole comprise a robust example of a range of Northwest ecotones: conifer forest, deciduous forests, wetlands, steep and shallow slopes, and grasslands. The many native species help to distinguish these unique environments across campus. The range of introduced species help to bolster the educational value of the urban forest and can demonstrate strategies for climate adaptation. As the campus evolves, data collection and tracking will be important for evaluating the University's progress towards a resilient urban forest. Incorporating that data into management strategies will enhace the condition of the University's urban forest for the benefit all life on campus.

Land Cover

LAND | WATER | BUILDINGS | INFRASTRUCTURE

The focus area for the Urban Forest analysis is within the surveyed areas of the University's Major Institution Overlay or MIO. The MIO defines the area that the University is required to manage to standards set by the university and city; this includes all hardscape, softscape, buildings, vegetation, utilities, and water that falls within the boundary. One thing to note is that some areas of campus (see map below) have not had their trees inventoried, but do provide significant value to the campus's urban forest and are included as part of the University's tree canopy analysis. To establish a baseline for analyzing the campus's urban forest, the existing ground conditions have been quantified by thee primary land use types found on campus: structures, water, and land.





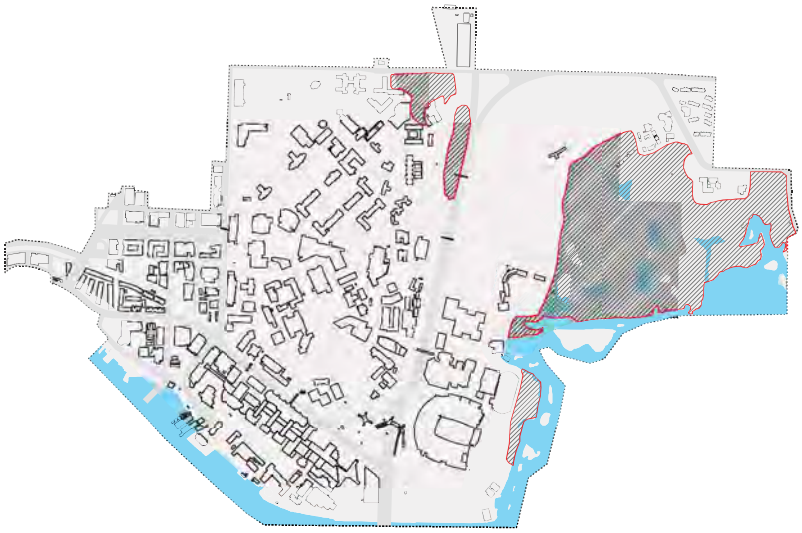
Land Cover

Total MIO Area: **669 acres**

Land : **597 acres**

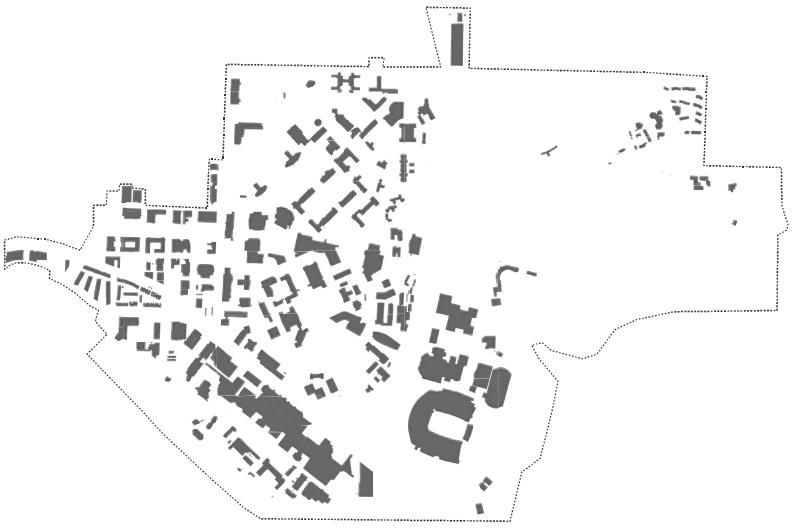
Water : **72 acres**

Public Right of Way : **66 acres**



Future Survey Area

Total Area : **90 acres**
15% of Land Area



Building Coverage

Building Count : **289**

Footprint Area : **105 acres**
18% of Land Area

2023 Tree Database

GIS | GPS

The following analysis of the University of Washington Seattle Campus's urban forest was completed using ArcMap 10.8.2, Illustrator, InDesign, AutoCAD, and Microsoft Excel. The tree database was acquired in July of 2023 from the Campus Arborist who regularly updates the database when trees are planted or removed. With the campus in constant flux, this analysis represents a snapshot in time that builds on the baseline established by the 2016 publication of this document.

100 TONS

Campus Trees Sequester Enough Carbon Annually to Offset All UW Tri-Campus Scope 2 Emissions

UW Sustainability

The creation of a GIS Tree Database began with data collection in September 2005 when UW Seattle's Grounds Management started developing a tree inventory with the goal of qualifying and quantifying every tree on campus. The initial effort mapped approximately 9,200 of an estimated 11,000 trees on the Seattle Campus. Each surveyed tree is tagged with a unique number, measured for diameter at standard height (DSH) and overall height, classified, specie name identified, the number of stems counted, and condition rated. A custom, in-house GIS interface has been developed that allows University Grounds' personnel to access and update tree data in the field using a cell phone or tablet device. Updating the database as the landscape evolves while trying to finish the campus survey is an important goal that needs to be resolved for the University to maintain and possess an comprehensive snapshot of what exists to track goals and the condition of the University's urban forest.

The GIS mapping tools produced by the university allows the campus arborist to monitor all trees on campus, while being able to preserve historic data providing a historical narrative for the trees on campus. Notes and additional data can also be time stamped within the database making the information more robust. A publicly accessible dataset of the campus trees dataset is available through WAGDA 2.0; a university-specific data portal giving students and researchers access to the information for data analysis.

The data used for the canopy analysis was derived from a LiDAR scan completed by the City of Seattle in 2021. The other data used to create all of the maps that follow were acquired from the WAGDA 2.0 database and the University of Washington internal GIS databases. This includes building outlines, landscape feature outlines, pavement edges, shorelines, MIO boundary, and right-of-way. All Additional map data is approximated by georeferencing hardcopy maps using know points and then tracing the features into a new feature class.

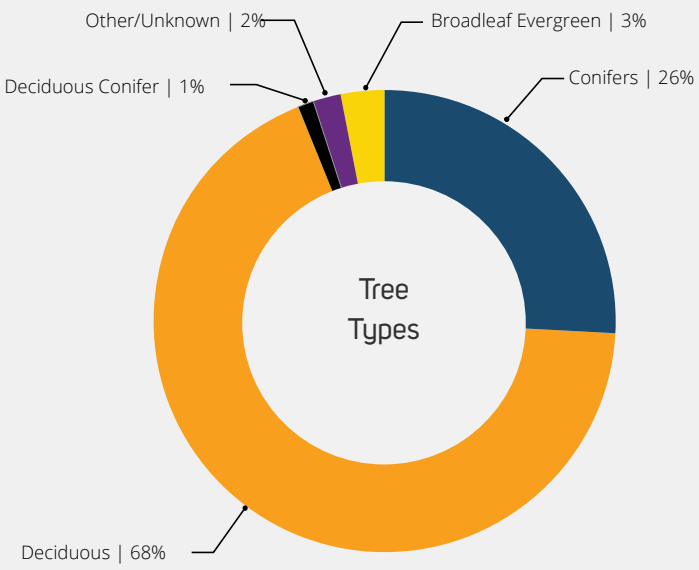
All Trees

9,192 TREES | 573 SPECIES

The Seattle campus has 9,192 inventoried trees, including 573 different species each providing value to the character and quality of the landscape experience. The health and diversity of the University's forest speaks to the Husky spirit of stewardship to the campus and the local environment. Through strategic care and management the University strives to provide a diversity of trees and distinct landscapes that emphasizes the variety of ecological zones that are native to the Pacific Northwest; from herbaceous wetland to Lowland Conifer-Hardwood Forest. Continuing to enhance the campus's biodiversity while improving the overall health of the urban forest is paramount for minimizing potential tree loss due to pests and severe weather. The trees paired with the landscape act as an educational resource that pushes the classroom outside of buildings to encourage hands-on, experiential learning techniques that helps realize the campus as a living laboratory for students, faculty, and staff. Growing this campus resource by increasing the number of species and trees on campus will help build upon the University of Washington's legacy of being good stewards.

$23.6 MILLION

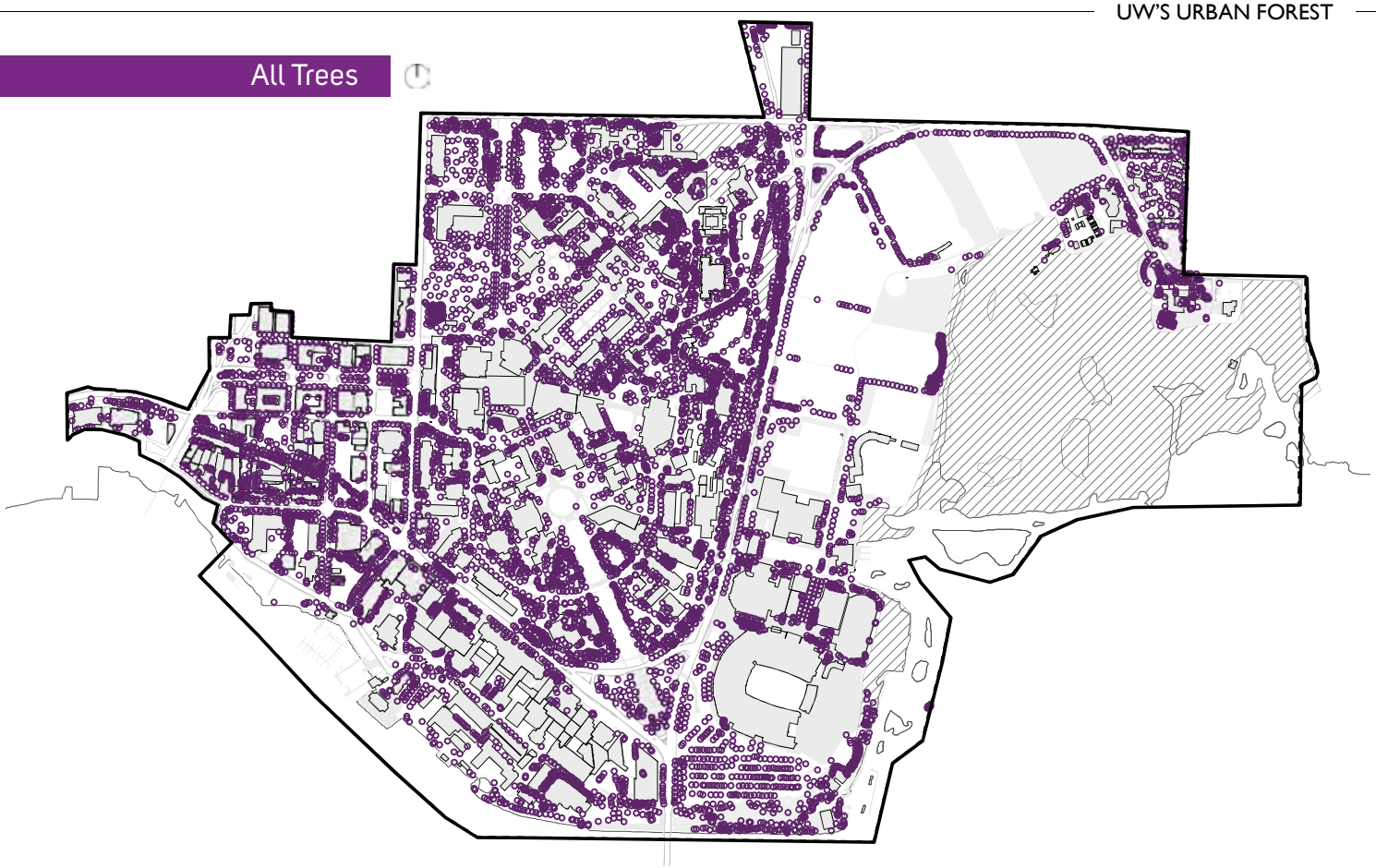
Replacement Value of Inventoried Trees



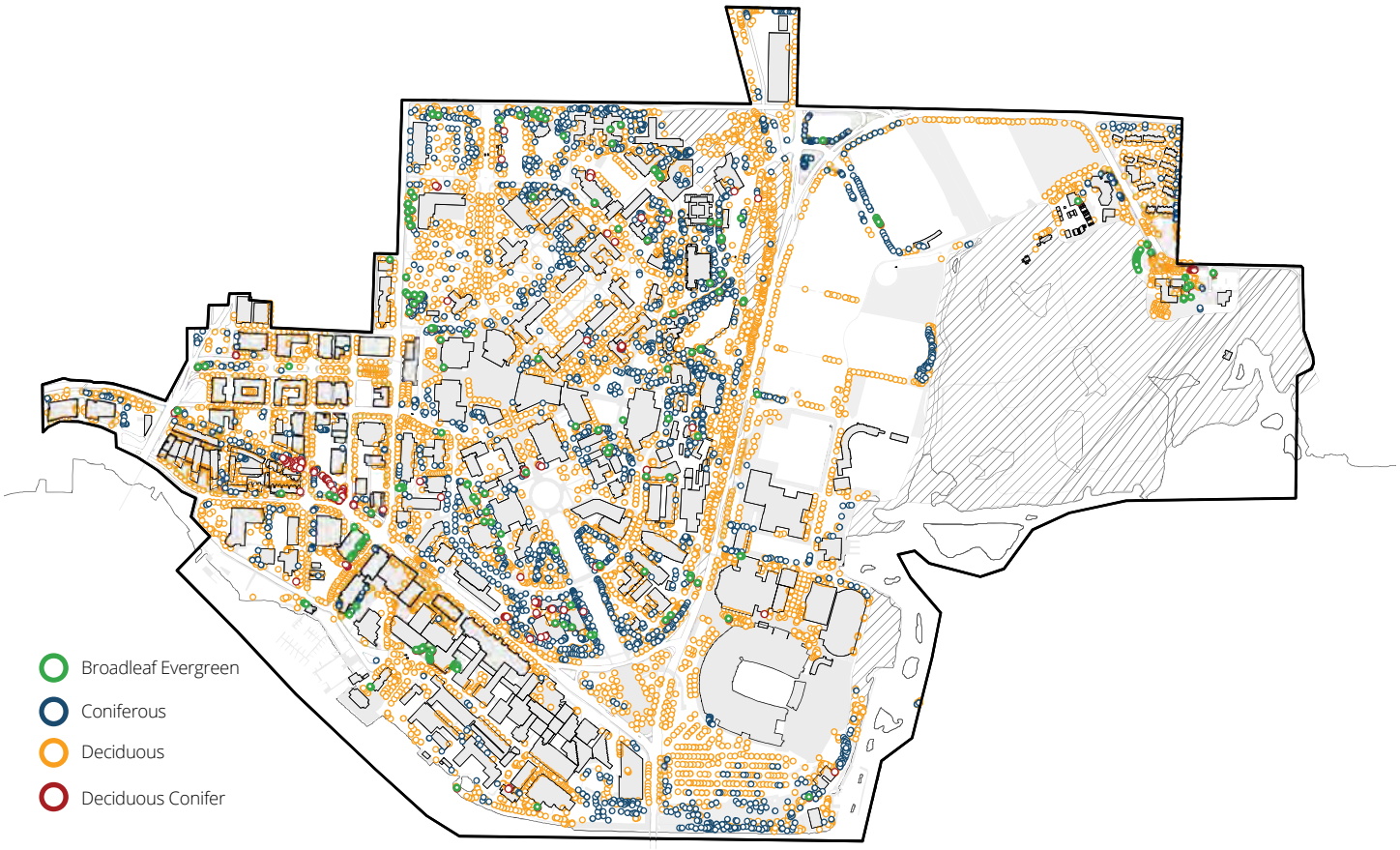
Most Common Species

Tree Species	# of Trees
Acer macrophyllum	733
Pseudotsuga menziesii	532
Acer circinatum	479
Quercus rubra	254
Thuja plicata	217
Chamaecyparis lawsoniana	200
Pinus sylvestris	162
Calocedrus decurrens	152
Cedrus deodara	149
Liriodendron tulipifera	145

All Trees



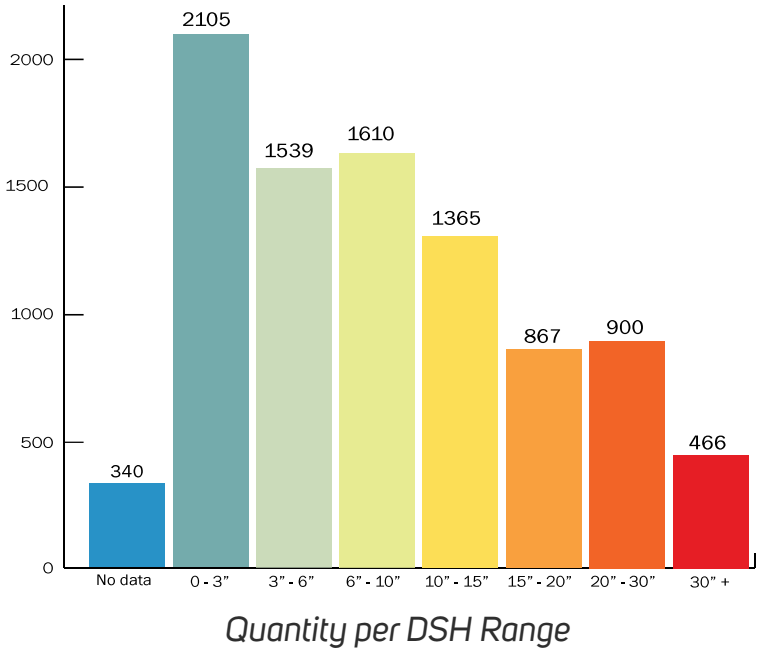
Trees Type per species



Diameter at Standard Height

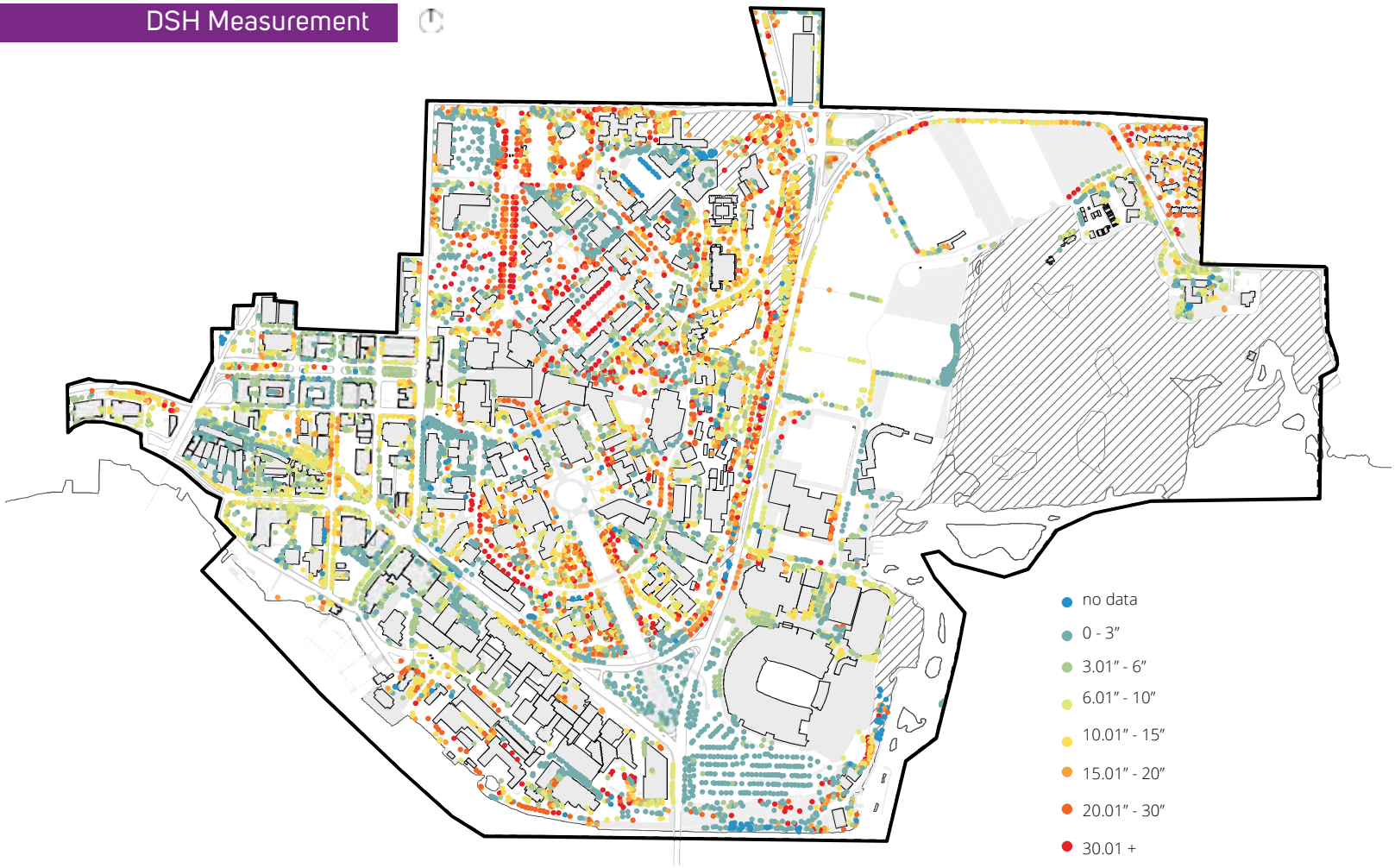
TIER | CALIPER | DSH

The Diameter at Standard Height measurement or DSH is a standard dimension taken at 4.5 feet above the base of the tree. The DSH measurement can be used to extrapolate other dimensions of a tree, such as tree height, crown volume, and age. The City of Seattle uses this measurement to define which trees are Tier 2, 3, or 4. The majority of trees on campus have a DSH less than 15 inches with only 466 tree above 30 inches. It is important for the University to have a range of trees with varying DSHs to provide a diverse urban forest that consists of a range of species at different sizes and ages.



Quantity per DSH Range

DSH Measurement

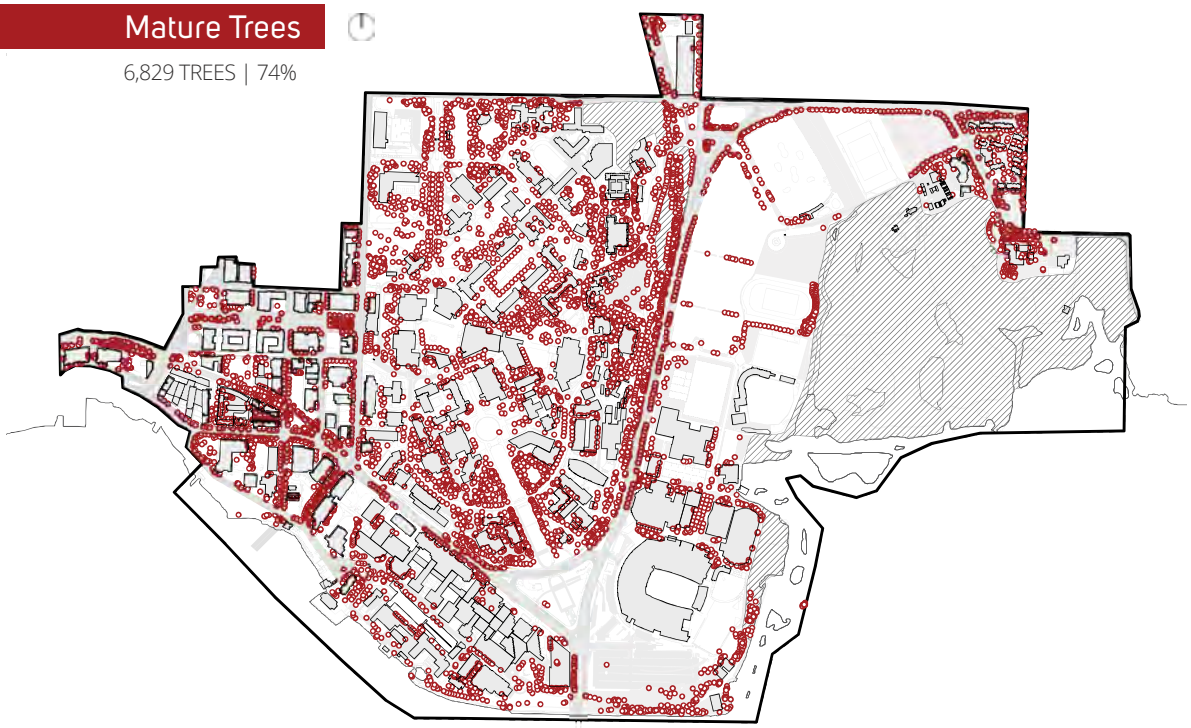


Tree Age

A healthy forest is comprised of trees with varying ages to help reduce the possibility of simultaneous large volumes of tree loss. The age of trees on campus have been divided into two categories, young and mature, based on recorded planting date. Young trees are defined as trees planted within the previous 20 years and mature trees are defined as trees planted more than 20 years ago. This revealed that the majority of trees are over 20 years old. There is a need to diversify the ages of trees on campus by strategically adding new trees annually with new construction projects and tree replacement.

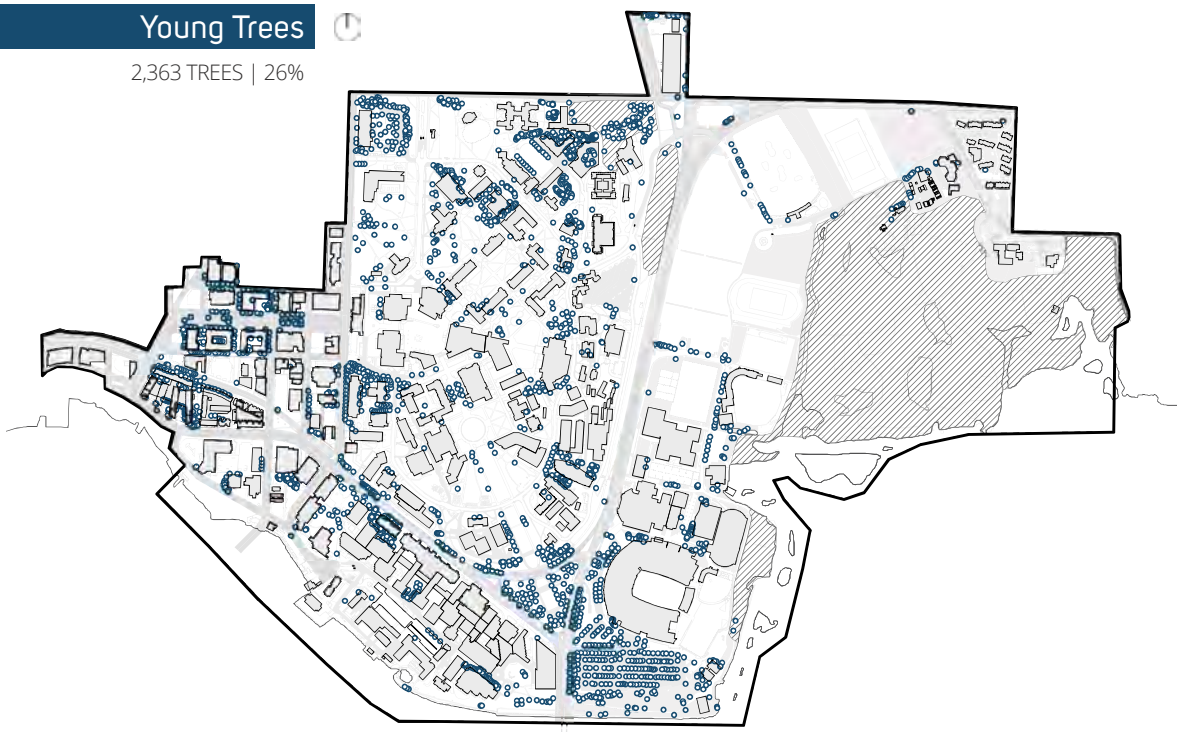
Mature Trees

6,829 TREES | 74%



Young Trees

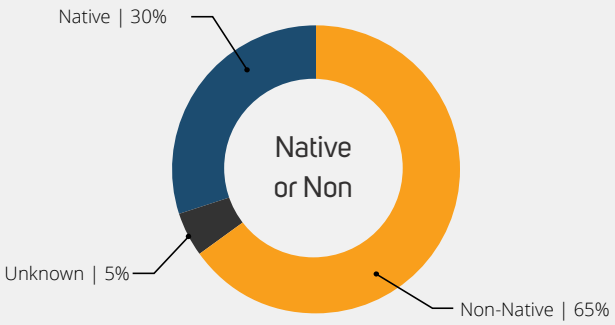
2,363 TREES | 26%

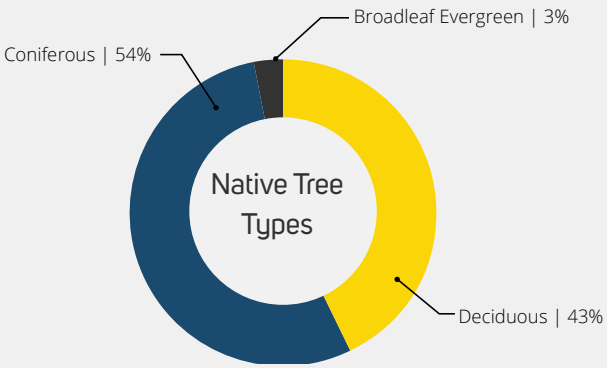


Native Trees

2,756 TREES | 41 SPECIES

Native Trees are valuable assets to the campus because of their natural acclimation to the Northwest climate and their benefit to wildlife habitat. Native trees have naturally aligned their watering and nutrient needs with the local climate which reduces irrigation requirements, reduces disease risk, enhances the local ecology, and helps limit the introduction of potential invasive species into the landscape. The University has slightly less number of native conifers compared to native deciduous trees. With only 30% of inventoried campus trees being native species, the University has the opportunity to enhance the biodiversity and improve wildlife habitat by introducing more native species into the landscape. The University recognizes the benefits of native trees but also feels that a healthy urban forest needs to respond to the existing conditions which are greatly altered from what was present historically, making natives not always the most ideal choice. Without fully being aware of the impact climate change will have on the region, exploring non-natives species could be a means towards identifying which tree species may thrive here in the future.



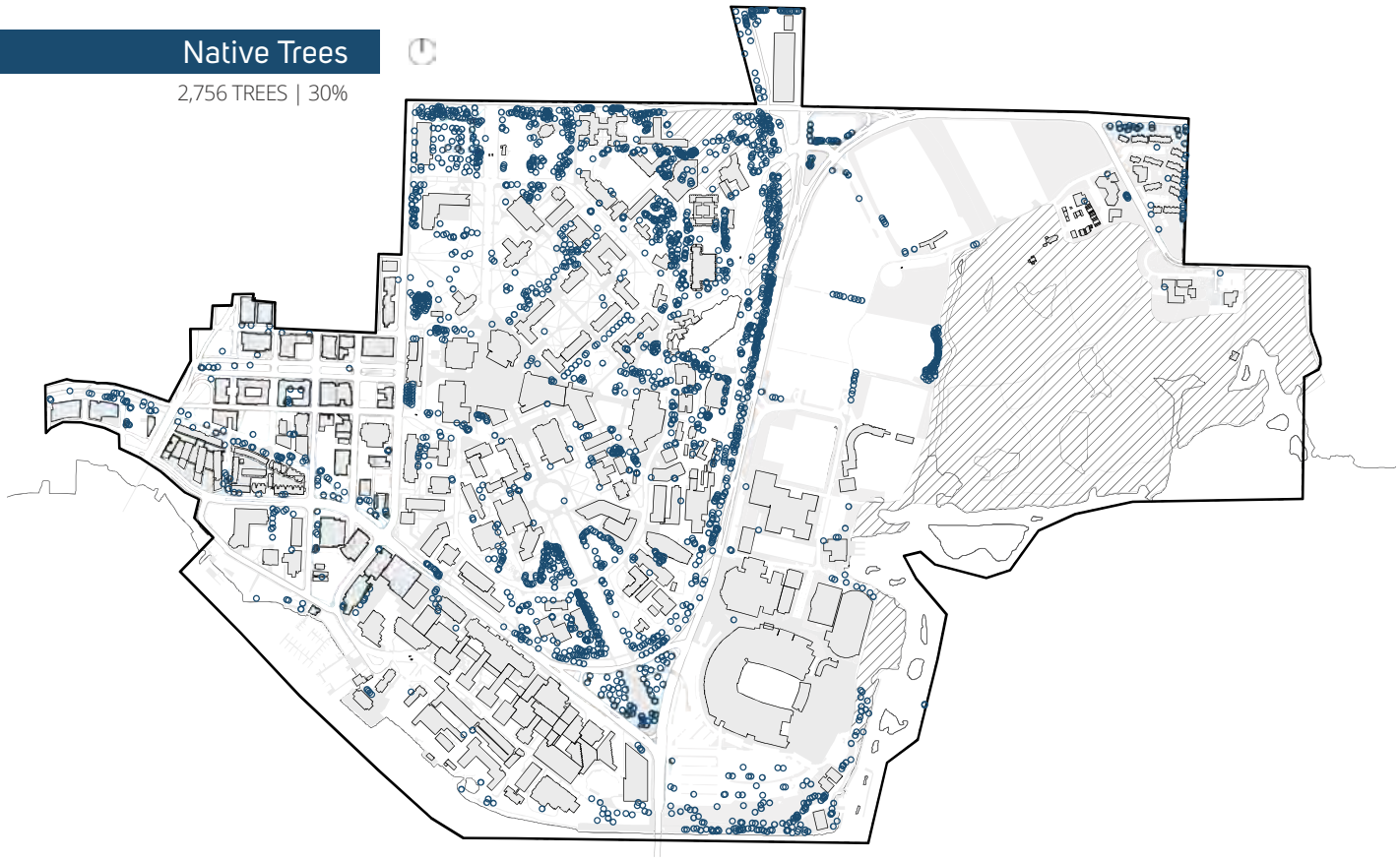


Most Common Native Species

Tree Species	# of Trees
Acer macrophyllum	*733*
Pseudotsuga menziesii	*532*
Thuja plicata	*217*
Chamaecyparis lawsoniana	*200*
Calocedrus decurrens	*152*
Pinus contorta	*109*
Arbutus menziesii	*90*
Fraxinus latifolia	*71*
Tsuga heterophylla	*63*
Amelanchier alnifolia	*51*

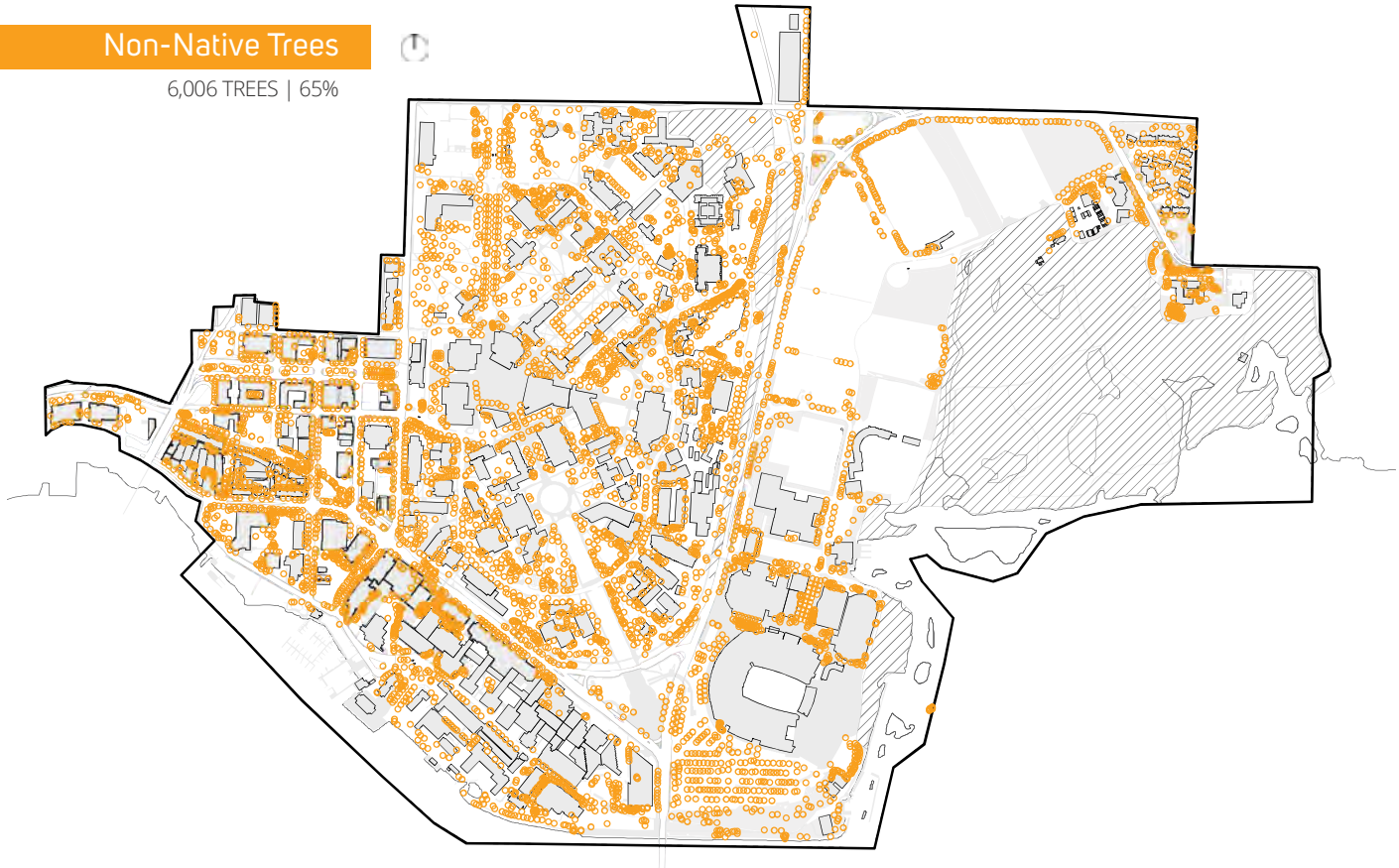
Native Trees

2,756 TREES | 30%



Non-Native Trees

6,006 TREES | 65%



Coniferous Trees

2,397 TREES | 92 SPECIES

Historically, Washington was dominated by conifer forests that were logged extensively over the past 150 years and what remains are scattered patches of old-growth forests across Western Washington. This has impacted the natural succession of Washington's forest that are now dominated by deciduous trees. Currently, Seattle has 37% of its urban forest as coniferous (2021) while the University's urban forest consists of 26% conifers (2023). Five of the top ten most prevalent species on campus are conifers with the highest densities of conifers being along the edges of central campus. Conifers are unique in that they provide environmental services all year long; improve air quality, provide wind and noise barriers, provide shade, and help retain stormwater runoff caused by impervious surfaces. Leveraging the environmental services offered by conifers could help the University protect areas from prevailing winds, shade buildings to reduce energy costs, and help manage stormwater on-site. One thing to note is that native varieties of conifers on campus are of a higher value than non-natives which could be the result of them being healthier due to their natural acclimation to the local ecology.

26%

of Trees on Campus are Conifers

75,000+ gal

Campus Pseudotsuga menziesii Annual Stormwater Uptake

4+ Tons

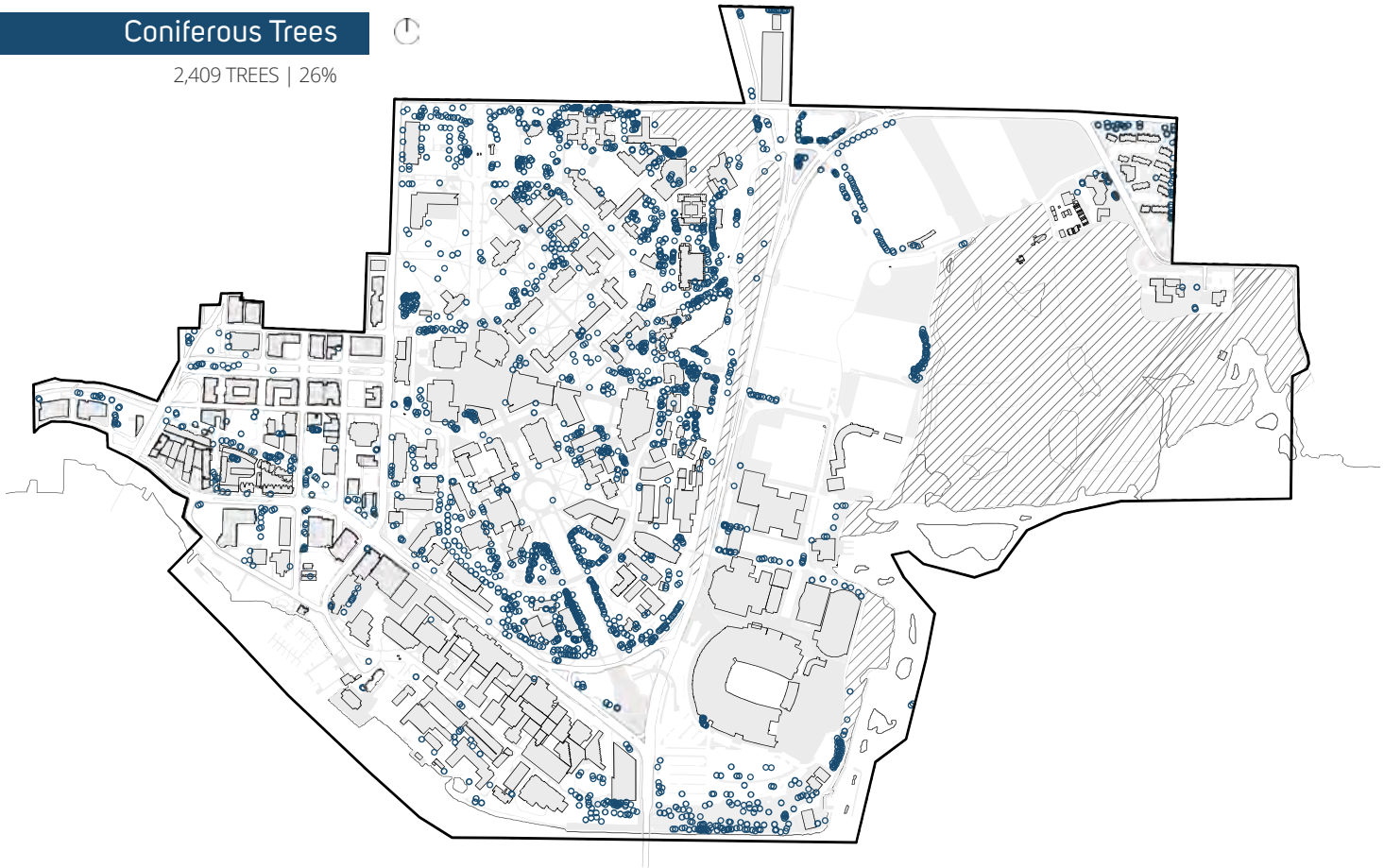
Campus Pseudotsuga menziesii Annual Carbon Storage and Sequestration

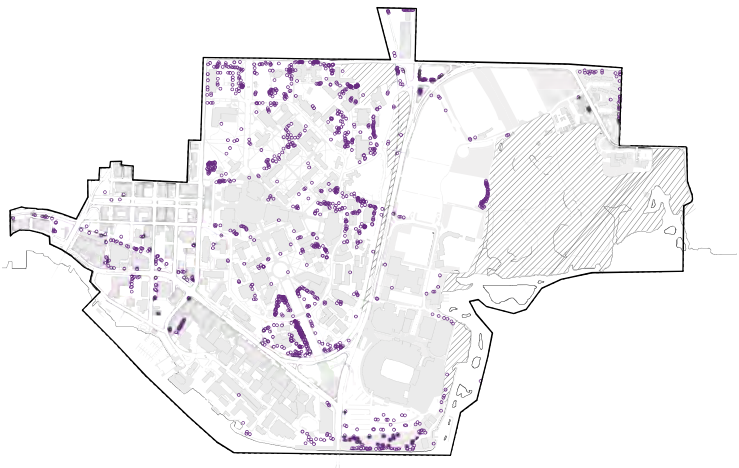
Most Common Coniferous Species

Tree Species	# of Trees
Pseudotsuga menziesii	*532*
Thuja plicata	*217*
Chamaecyparis lawsoniana	*200*
Pinus sylvestris	*162*
Calocedrus decurrens	*152*
Cedrus deodara	*149*
Pinus contorta	*109*
Pinus nigra	*92*
Tsuga heterophylla	*63*
Sequoia sempervirens	*45*

Coniferous Trees

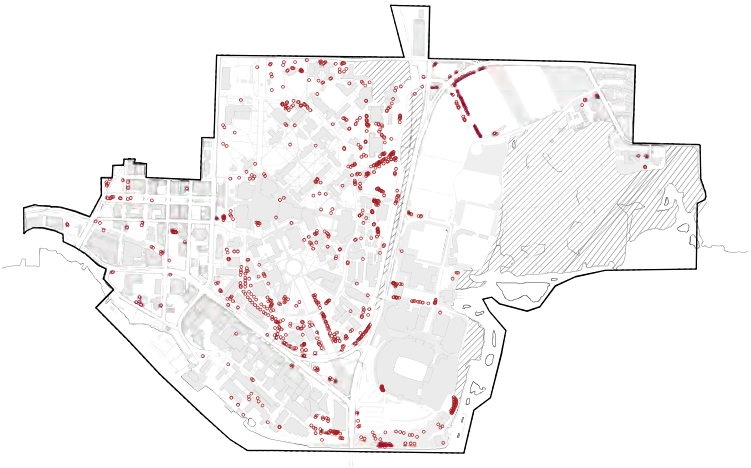
2,409 TREES | 26%





Native Conifers

1,473 TREES



Non-Native Conifers

927 TREES

Deciduous Trees

6,272 TREES | 330 SPECIES

With 303 deciduous species planted on campus, the University has a vast living resource. The amazing autumn color that is offered by Northwest deciduous trees is a cultural legacy that is celebrated by residents and visitors with trips to Northwest forested landscapes throughout the year. The majority of this region's old-growth forest has been replaced with deciduous trees that vary in their ability to produce food, flowers, and other resources. Strategically locating deciduous trees on the south and west side of buildings, around open space, and along critical areas can help create micro-climates to reduce energy costs, stabilize slopes, and provide shade. A limitation of deciduous trees is that they provide half the stormwater management value that conifers offer because they are dormant during Seattle's wet months. There are some exceptions, for example, Quacking Aspen, *Populus tremuloides*, is a unique deciduous tree species. This deciduous tree species has the ability to photosynthesize during the winter when other deciduous trees are dormant.

225,000+ gal

=

50% of an olympic swimming pool

= The Annual Stormwater Uptake By *Acer macrophyllum* Trees on Campus

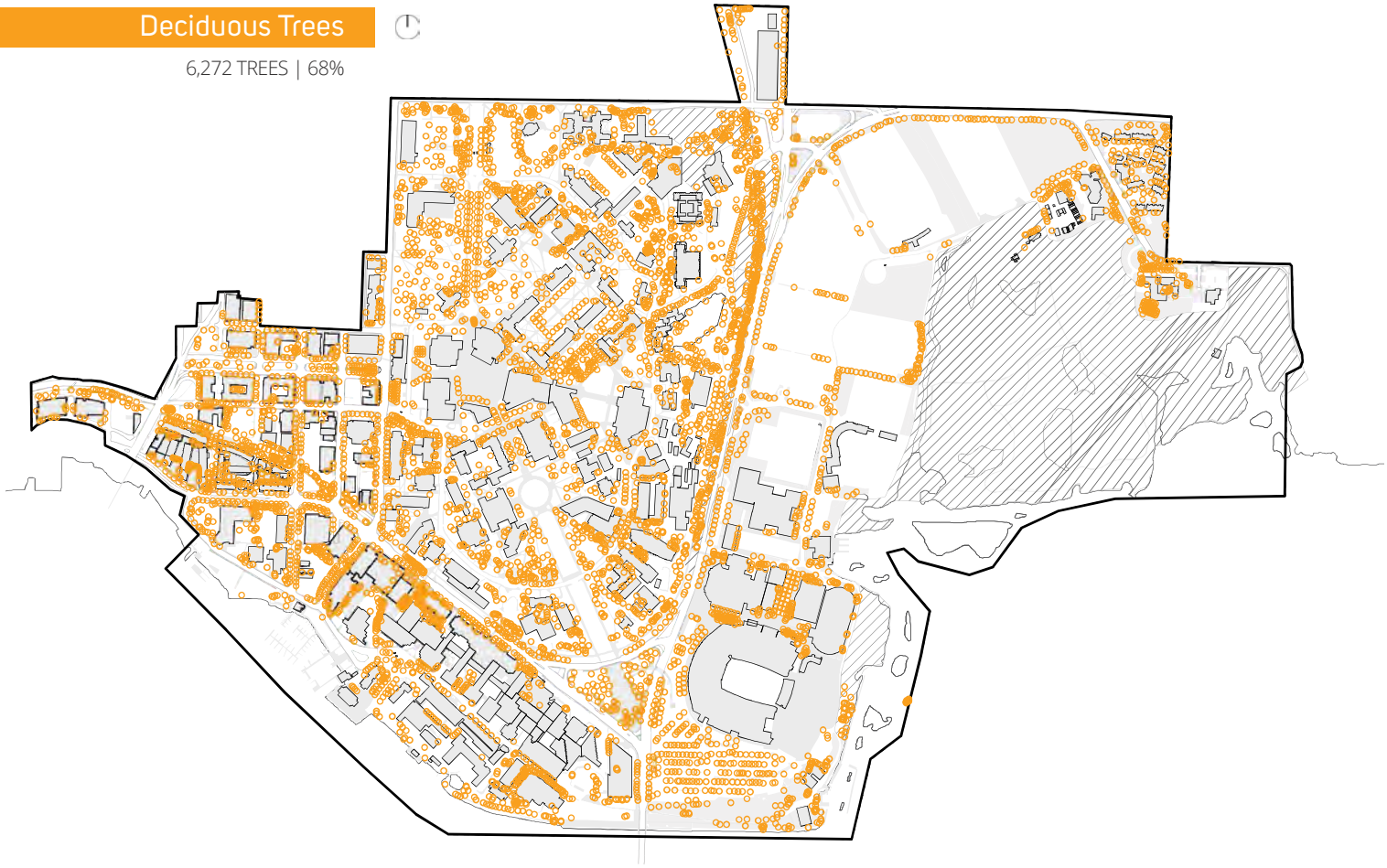
i-Tree Ecosystem Analysis

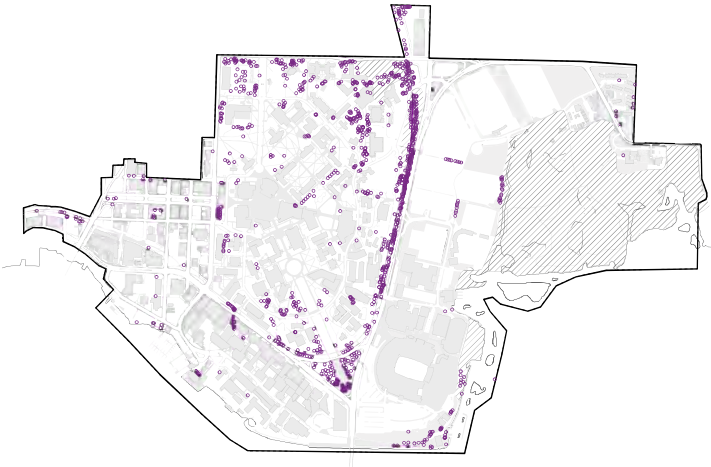
Most Common Deciduous Species

Tree Species	# of Trees
Acer macrophyllum	733
Acer circinatum	479
Quercus rubra	254
Liriodendron tulipifera	145
Acer rubrum	141
Platanus x acerifolia	138
Quercus palustris	132
Carpinus betulus 'Fastigiata'	128
Acer palmatum	99
Liquidambar styraciflua	90

Deciduous Trees

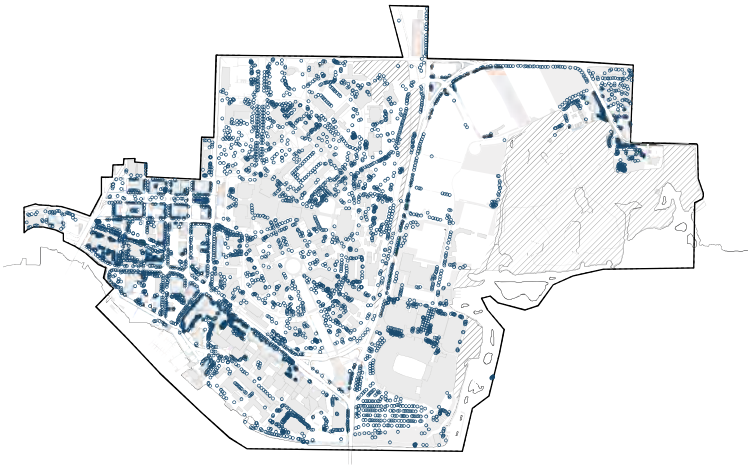
6,272 TREES | 68%





Native Deciduous

1,193 TREES



Non-Native Deciduous

4,827 TREES

Broadleaf Evergreen Trees

265 TREES | 24 SPECIES

Broadleaf evergreens are trees or shrubs that have broad rather than needle like scaled leaves and maintain their leaves through out the year. They offer the color and fruit production of a deciduous tree while providing shade and canopy cover year-around. Shrubs can also be classified as a broadleaf evergreen with the state flower, *Rhododendron macrophyllum*, being one example. Both broadleaf evergreen trees and shrubs are susceptible to winter burn or desiccation caused by freezing temperatures which causes the plant to be unable to draw moisture from the frozen soil. With only 265 broadleaf evergreen trees and *Arbutus menziesii* representing 34% of them, the University can increase the number of types and specimens on campus. A challenge to increasing the diversity of broadleaf evergreens, like other tree varieties, is favorable site conditions and availability at local nurseries.

3 tons =

The Weight of The Broken Obelisk Sculpture in Red Square

4 tons =

The Amount of Oxygen Produced Annually by Campus *Arbutus menziesii* Trees

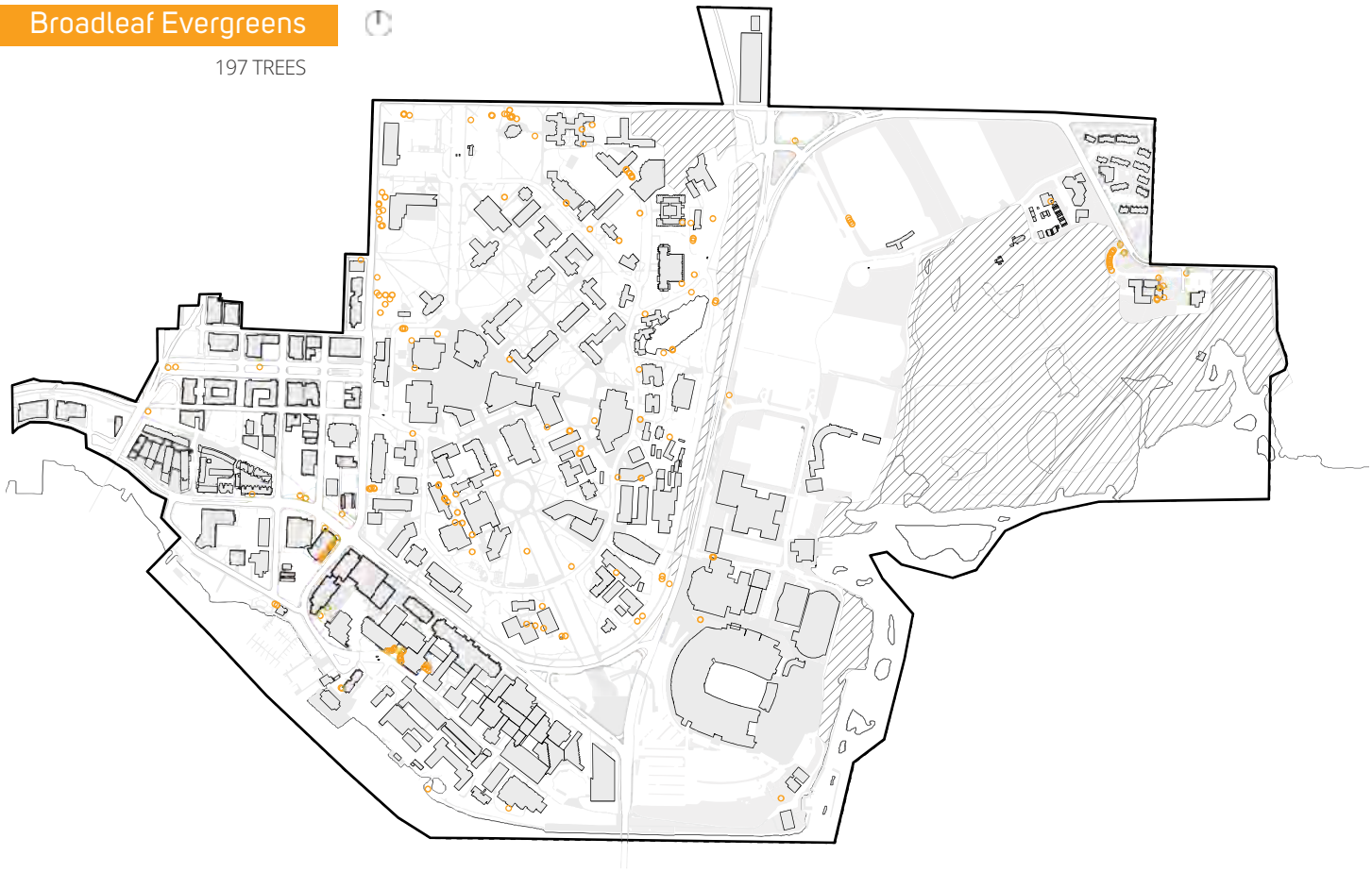
i-Tree Ecosystem Analysis

Most Common Broadleaf Evergreen Species

Tree Species	# of Trees
Arbutus menziesii	90
Arbutus unedo	74
Laurus nobilis	17
Ilex aquifolium	12
Ilex x 'September Gem'	11
Magnolia grandiflora	11
Eucalyptus sp	10
Azara microphylla	7
Ilex x altaclarensis 'Camelliifolia'	6
Ilex sp	4

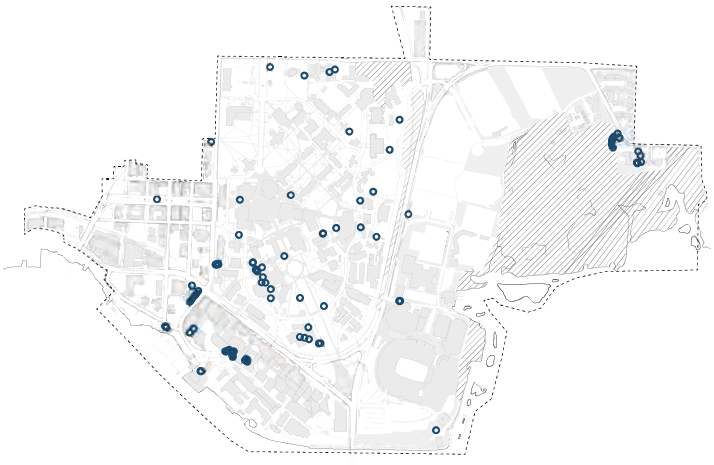
Broadleaf Evergreens

197 TREES



Native Broadleaf Evergreens

90 TREES



Non-Native Broadleaf Evergreens

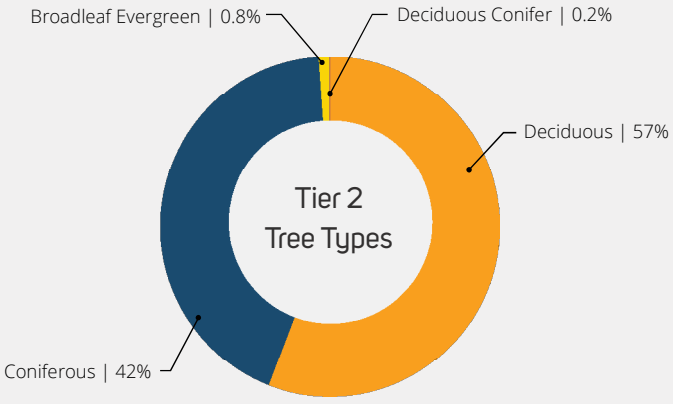
105 TREES

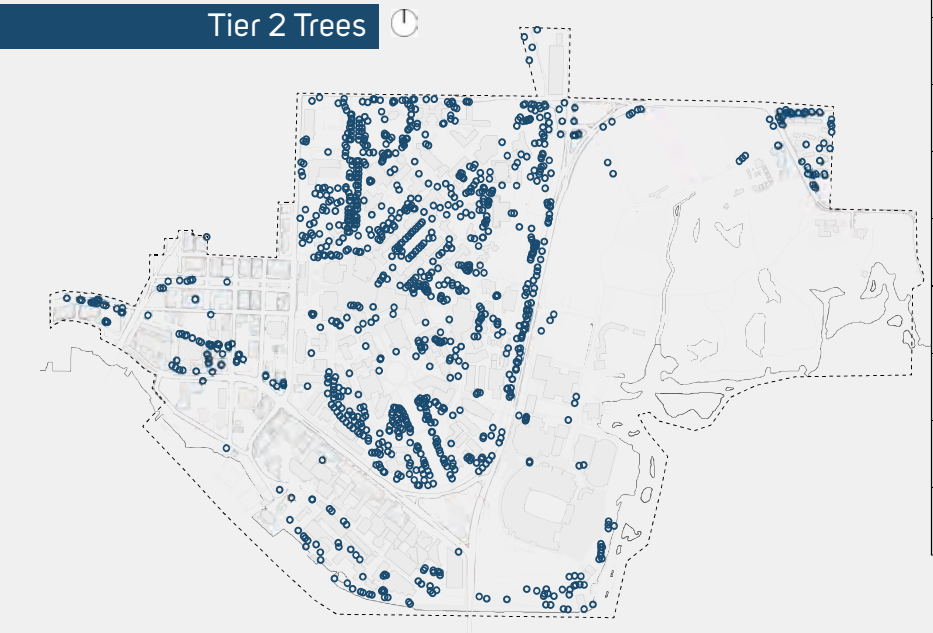
Tier 2 Trees

1,114 TIER 2 TREES | 113 SPECIES

City of Seattle Tier 2 trees provide the University with culturally significant specimens that offer habitat benefits and enhance the overall quality of the campus landscape. These trees have been identified based on the City of Seattle's SDCI Director's Rule 7-2023. Tier 1 trees are heritage trees (defined in Seattle Municipal code, Title 15), none of which are on campus.

Tier 2 trees are any tree with a DSH of 24" or greater or meets or exceeds the threshold diameters specified by the Director's rule for specific tree species with a threshold below 24". For example, vine maples, *Acer circinatum*, must meet a DSH threshold of 8 inches to be classified as Tier 2 trees.





Most Common Tier 2 Trees

Tree Species	# of Trees
Acer macrophyllum	128
Pseudotsuga menziesii	125
Pinus contorta	86
Platanus x acerifolia	82
Cedrus deodara	77
Quercus rubra	39
Acer circinatum	35
Thuja plicata	29
Aesculus hippocastanum	27
Prunus x yedoensis 'Akebono'	25
Populus nigra	24

** This page does not include Tier 2 trees as part of groves and trees 75% the size of the largest documented trees*

Memorial Trees

278 TREES | 49 SPECIES

Following major events in history, the University has completed multiple tree plantings on campus to honor students, veterans, professors, and faculty associated with these events. In addition, individuals are able to purchase a memorial tree for a loved one or colleague that is maintained in perpetuity by UW Grounds Management and showcased on a Memorial Tree map that can be found online. A short list of memorial plantings of interest are the allée of London Plane (Platanus x acerifolia) trees that line Memorial Way to honor the 58 students that died in World War I, Douglas Firs (Pseudotsuga menzieseii) for Jewish Arbor Day, and the Giant Dogwoods (Cornus controversa) that honor the victims of September 11, 2001. The trees on campus not only represent the amazing ecology of the northwest but also provide moments to reflect and honor veterans, and influential faculty that have left a cultural or social impact on the University community and society. The continued promotion and expansion of this resource can help increase the awareness of the multiple layers of value and significance that many campus trees possess.

76

Memorial Trees are also Tier 2 Trees

$1,000

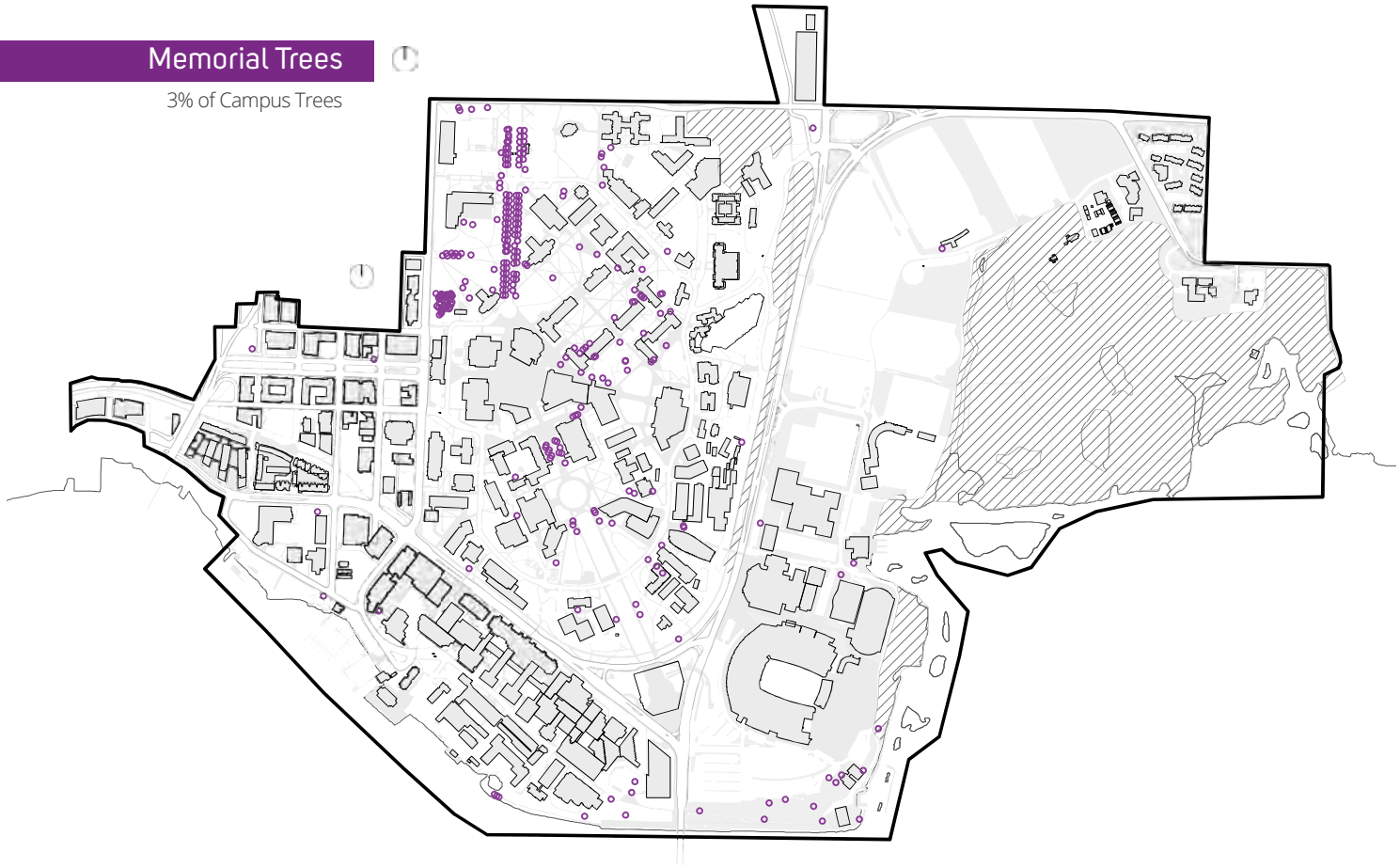
Cost to Purchase and Maintain a Memorial Tree on Campus for Three Years

Most Common Memorial Trees

Tree Species	# of Trees
Platanus x acerifolia	99
Pseudotsuga menziesii	35
Prunus serrulata 'Shirofugen'	11
Quercus coccinea	10
Prunus x yedoensis 'Akebono'	9
Thuja plicata	8
Cornus kousa	4
Magnolia X 'Galaxy'	4
Amelanchier x grandiflora 'Autumn Brilliance'	4
Cornus controversa	3

Memorial Trees

3% of Campus Trees



TREE DEDICATIONS

Major Events

911 Victims, 2001
Armistice day, 1920
58 students who died WW1
Jewish Arbor Day

In Honor of.....

Annie Knight
Ben Athay, 2007
Bill Talley, 2007
Bob Anderson Memorial Tree
Charles "Griz" Graves
Chris Holmer and the Holmer family
Class of 2007
David Ogrodnik, 2013
Eugene G. Goforth, MD 1975
Holly Turner
Honor of Staff member Baby
In memory of an employee by fellows
Jill M Nakawatase
Laurence Walters Family
Lynn Guggenheim 1997
Lynns Tree
Mark Nelson
Martin Elder
Phil Johnson "UW Gardener"
Sigma Kappa Centennial Memorial Tree
UW Graduate John Messier
Walt Gordon
William Bergsma, UW School of Music Director, 1963-1971

Unique Trees

"The Miller Elm" for Francis G. Miller
Meany Oak
Centenneal Cedar by Mary Gates Hall

Special Trees

PINACEAE | SAPINDACEAE | CUPRESSACEAE | ROSACEAE

The University of Washington adds to the value of its urban forest by planting rare Northwest trees on campus that are curated as a campus tree tour in honor of Professor Frank Brockman, an influential professor in Forestry who created the first university tree tour in 1980. The University takes pride in utilizing the landscape as an educational resource by designing it also as an extension of the classroom. Rare trees on campus have been identified using the book, "Trees of Seattle" by Arthur Lee Jacobsen, a robust local tree guide that tries to identify and provide mature healthy examples of each unique tree species in the city. The Brockman Memorial Tree Tour currently consists of 81 trees that highlight the beauty and diversity of trees on campus through an online available tour with a printable map for those who would like to experience the trees on site.

1%

Of Campus Trees Are Special Trees

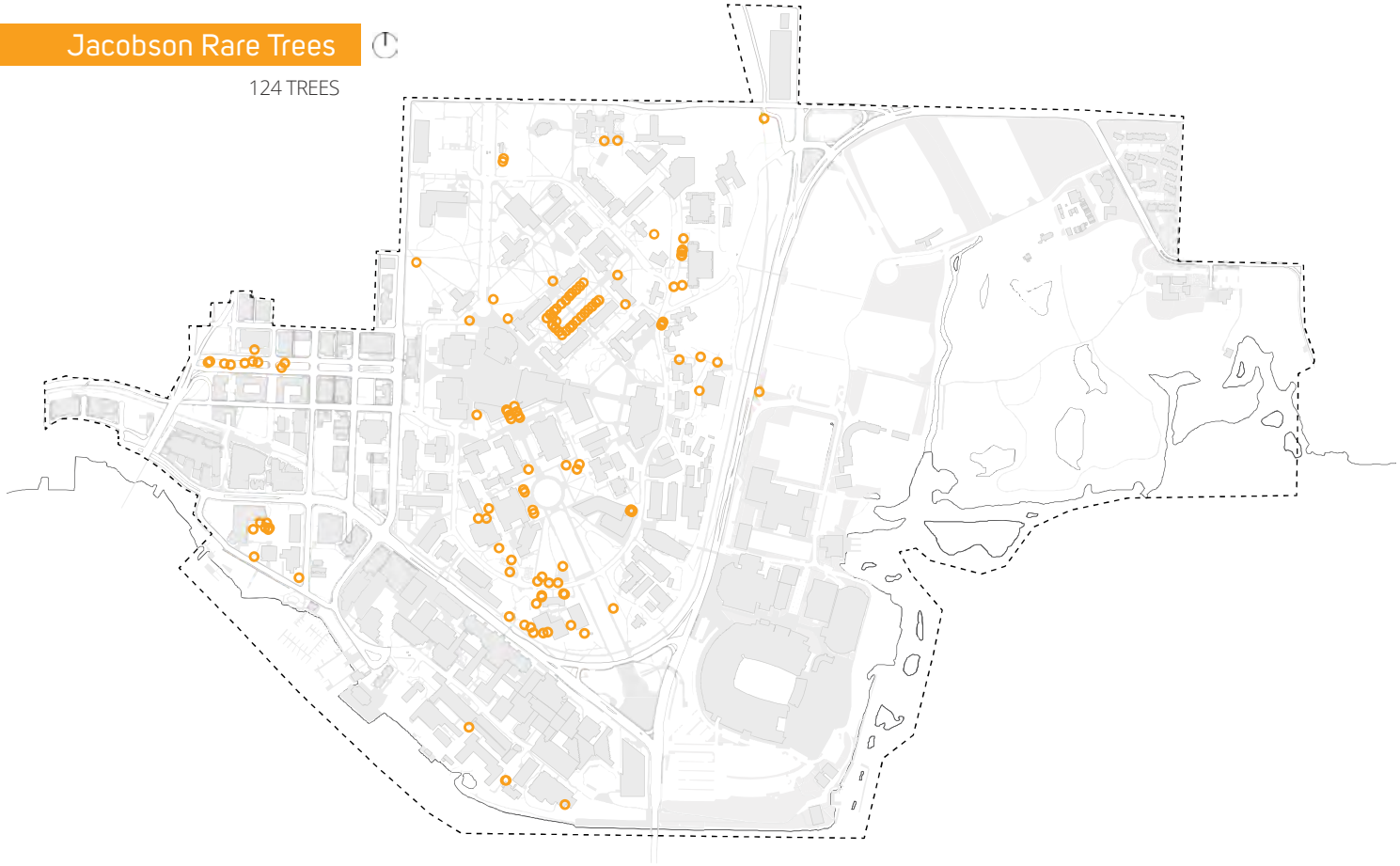
Prunus x yedoensis and person for scale. These trees, such as the specimen in the UW Quad, provide cultural value.

Most Common Jacobson Rare Trees

Tree Species	# of Trees
Prunus x yedoensis	*30*
Idesia polycarpa	*19*
Prunus serrulata 'Hisakura'	*9*
Pinus coulteri	*8*
Malus baccata	*7*
Acacia melanoxylon	*7*
Carpinus japonica	*5*
Crataegus pruinosa	*5*
Tilia cordata	*5*
Chamaecyparis pisifera	*4*

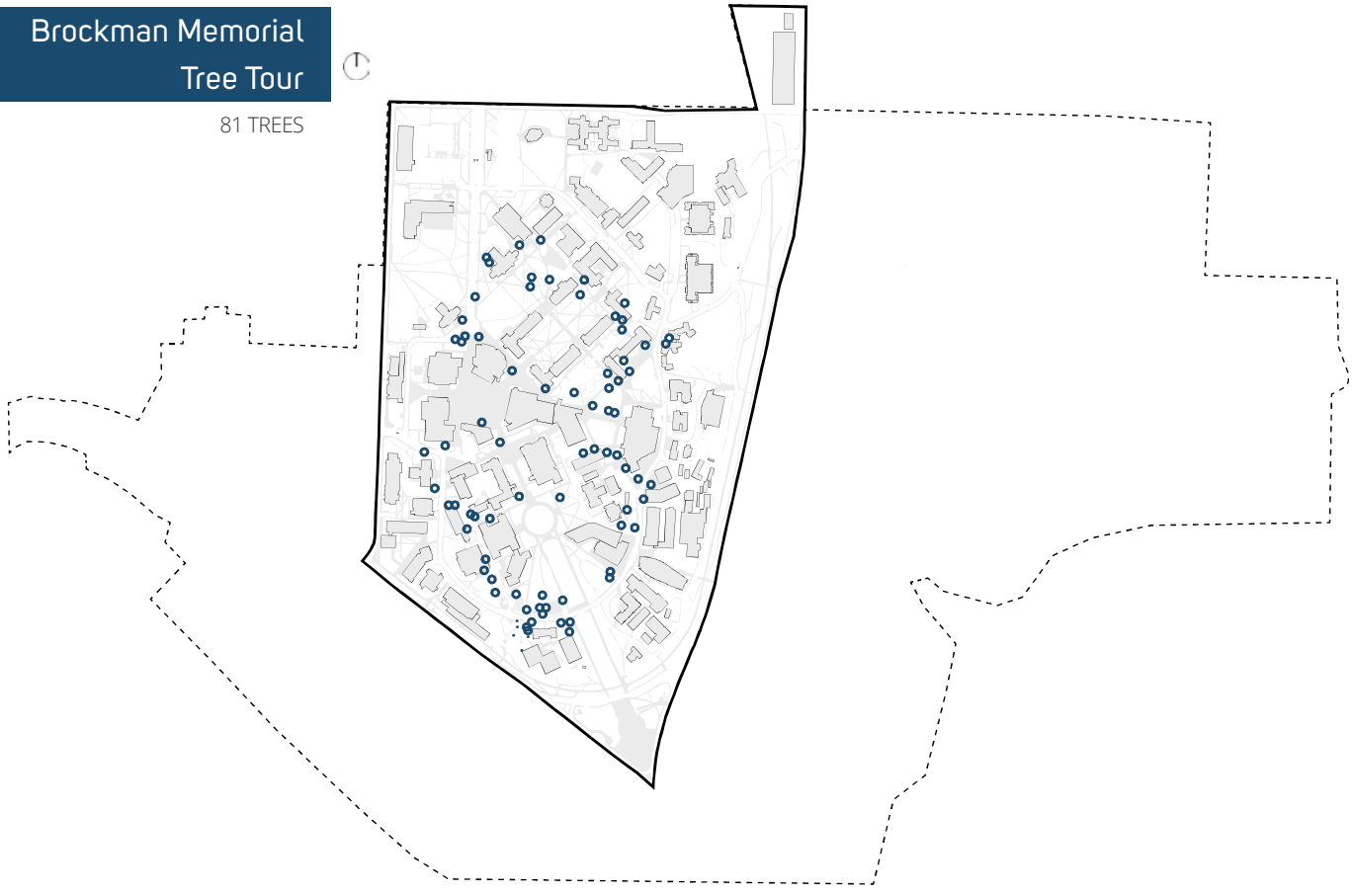
Jacobson Rare Trees

124 TREES



Brockman Memorial Tree Tour

81 TREES



Invasive Trees

121 TREES | 7 SPECIES

The University has approximately 121 trees on campus that have been identified as Class C Noxious Weeds by the Washington State Noxious Weed Control Board or are on the King County Weeds of Concern List. These species are not required to be removed but no more specimen should be planted. In some cases, invasive trees can spread quickly and dominate areas for trees within the limited available space on campus. Current barriers to invasive species removal include lack of staff time. Some species have natural defenses that make removal difficult or costly, such as *Ailanthus altissima* which has sap that causes blisters when it contacts skin. The following species have been identified as invasive and are scattered across campus:

Washington Class C Noxious Weeds

Tree-of-heaven – *Ailanthus altissima*

Common hawthorn – *Crataegus monogyna*

King County Weeds of Concern

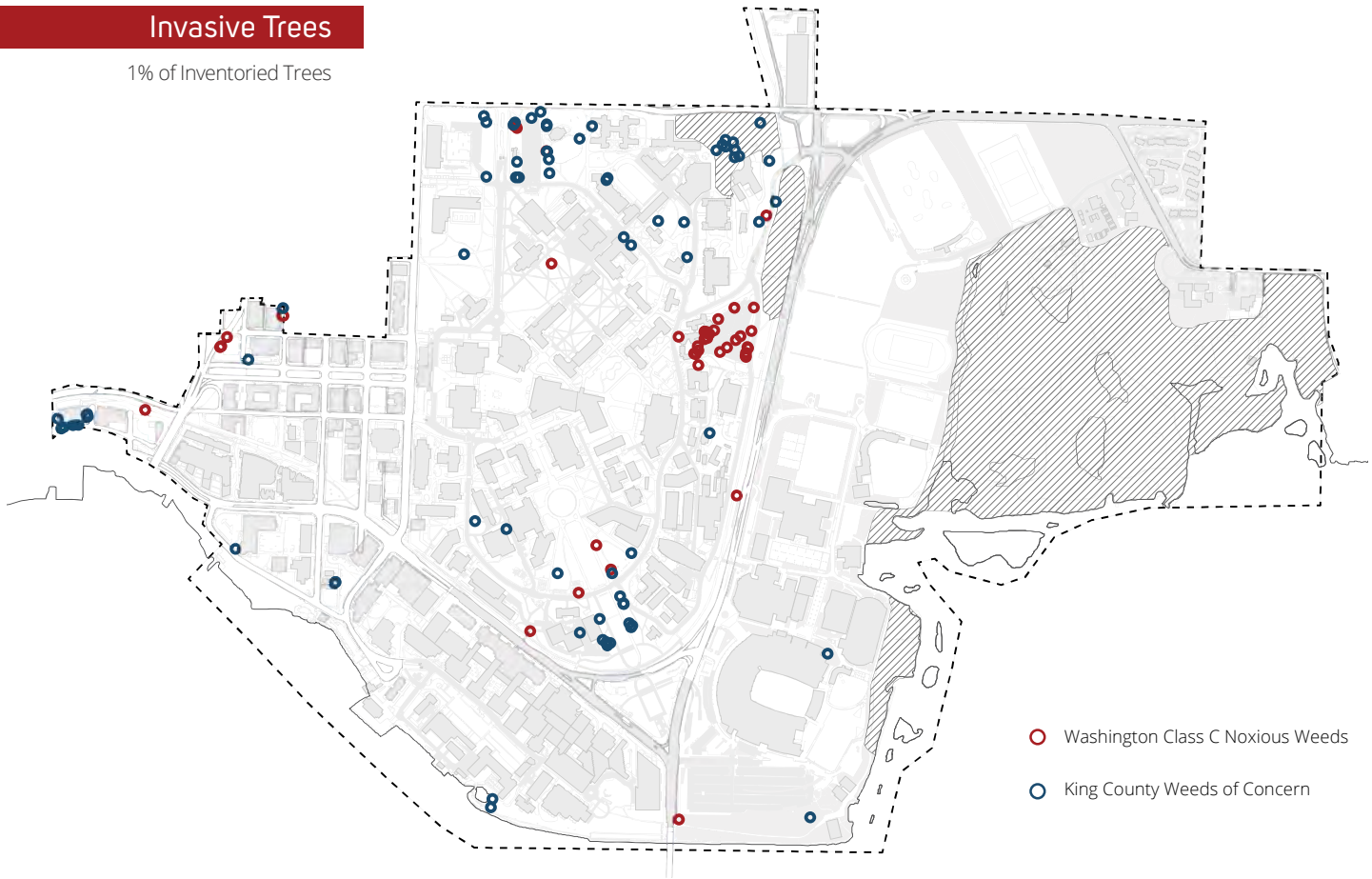
Sweet cherry – *Prunus avium*

Cherry laurel – *Prunus laurocerasus*

Black locust – *Robinia pseudoacacia*

European Mt. Ash – *Sorbus aucuparia*

English holly – *Ilex aquifolium*



Disease Susceptibility

INTEGRATED PEST MANAGEMENT | INOCULATION

All trees are susceptible to disease or insects, it's the fatal nature of their susceptibility that varies. The best way to protect a tree from harmful agents is to plant them in an ideal condition and maintain them to optimal health. Though not all disease or insects only attack unhealthy trees. Emerald Ash Borer, Dutch Elm, and Chestnut Blight attack trees of all conditions. Planting a diverse stand that is not limited to natives is ideal because many diseases and insects affect native plants. A ratio of no more than 10% of one species or 20% of one genus or 30% of one family is recommended to minimize the risk of massive disease infestation resulting in large volumes of tree death. Currently, the University is below the species and family thresholds but 21% of inventoried trees are in the *Acer* genus.

With the number of outbreaks growing, a diversity of trees need to be maintained in the urban environment to better protect the forest from a single vector destroying the canopy. Urban areas that have a concentration of individual species are more susceptible to a massive infestation. When establishing a tree palette for an area, it is not recommended to limit tree types to ones that are not associated with a major disease or insect risk, unless there have been high volumes of outbreaks. Overly restricting tree choices will put areas at risk of potential outbreaks caused by future unknown pests.

When a tree has been identified as potentially infected or diseased the University's Urban Forest Specialist conducts an evaluation of the tree. This helps the university determine the necessary means for resolving the hazard. A tree can be removed only when pruning, cabling, spraying, or injecting are not viable options for resolving the concern. The University takes advantage of integrated pest management to minimize its use of insecticides, fungicides, and pesticides because of their potential negative effects on soil biology, pollinators, water quality, and human health.

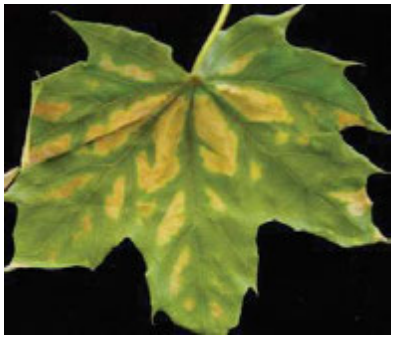
Dutch Elm Disease

Horse Chestnut Blight

Emerald Ash Borer

Bronze Birch Borer

Aphids



Verticillium Wilt

Dutch Elm Disease

ULMUS | TREATMENT ON-GOING

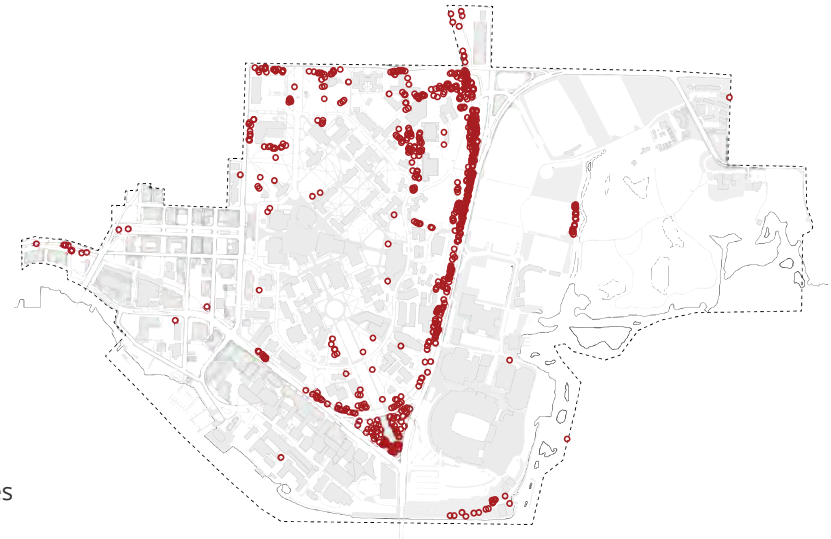
Dutch Elm Disease is caused by a fungi spread by elm bark beetles. It is currently a problem on the University of Washington Seattle Campus. The battle to save other Elms on campus is an on-going and difficult effort because of the elm bark beetle's mobility and fecundity. The existence of a large number of susceptible elm varieties on campus and in the surrounding communities makes this disease an ongoing concern.

The University grounds staff has been trained to identify the pest along with signs of infestation to assist in early detection and eradication. As part of the university's management strategy, roughly 70 susceptible elms are inoculated with the "Dutch Trig" vaccine each year while the more significant Elm trees on campus are treated with a Arbotech Macroinjection every two years. The University will continue using early detection and rapid response paired with injections to minimize future tree loss while also specifying elm varieties that are less susceptible to the Dutch Elm for new plantings.

Verticillium Wilt

ACER | CURRENT PROBLEM

Verticillium is a soil-borne fungi that attacks woody ornamental trees in the United States. Verticillium slowly spreads inside the tree causing a slow and long death. This infection is often confused with other tree impacts: herbicide damage, adverse environmental conditions, or mechanical damage. Nurseries using land that was previously growing infected plants are more susceptible to this disease. Certain trees are more susceptible to this disease while others are immune to it, such as Beech, Birch, Pine, and Poplar trees. Currently, this disease has been infecting trees on campus. The response is to immediately remove the tree and replace it with a different species. Big Leaf Maples are the most common species on campus and are highly susceptible to this disease. We must promptly remove affected trees to prevent this fungus from becoming a serious risk to the composition of the campus canopy.



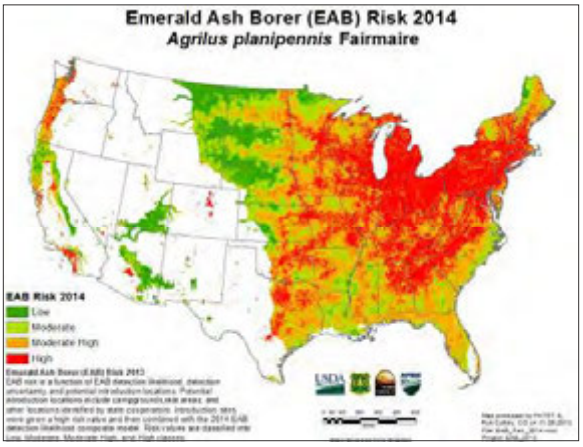
Acer Macrophyllum

733 TREES

Emerald Ash Borer

FRAXINUS | NO REPORTED CASES

Emerald Ash Borer (EAB) is an invasive beetle that was discovered in the Pacific Northwest in 2022. Experts expect that it will inevitably reach Seattle. In response, the University is working on an internal EAB Plan. The Emerald Ash Borer is a beetle associated with trees in the *Fraxinus* genus that feeds on foliage. Its larvae feed on the inner bark of ash trees which impacts the tree's ability to transport water and nutrients. The beetle is native to Asia and is assumed to have arrived in the U.S. on solid wood packing materials. The areas where this beetle is being reported have implemented quarantines to restrict its movement. The Puget Sound Region has been identified by the USDA as a high-risk area for potential outbreaks because of the robust forest and associated industries in the region. Establishing an early detection and response strategy to help educate staff about this pest will aid in reducing the impact of any outbreak that may occur.



Bronze Birch Borer

BETULA | CURRENT PROBLEM

The Bronze Birch Borer has been established in the Pacific Northwest since 2000 and is currently a problem on campus. Approximately 115 birch trees have been removed from campus between 2018 and 2023 due to bronze birch borer damage. The University has taken steps to preserve birch health and deter the borer by injecting birches with insecticide. However, due to limited resources, treatment efforts have been concentrated near roads. These selected trees are treated biannually to ensure the continued safe passage along roadways. The borers are most attracted to unhealthy trees so new birch trees should be planted in their ideal habitat, cool areas with moist soil and partial sun exposure with minimal foot traffic, to help minimize the spread of infestation. Also, selecting varieties that have greater resistance is also a good strategy for minimizing risk.

High Susceptibility

Betula pendula
Betula pendula 'Youngii'
Betula utilis var jacquemontii

Moderate Susceptibility

Betula papyrifera
Betula populifolia
Betula alleghaniensis

Minimal Susceptibility

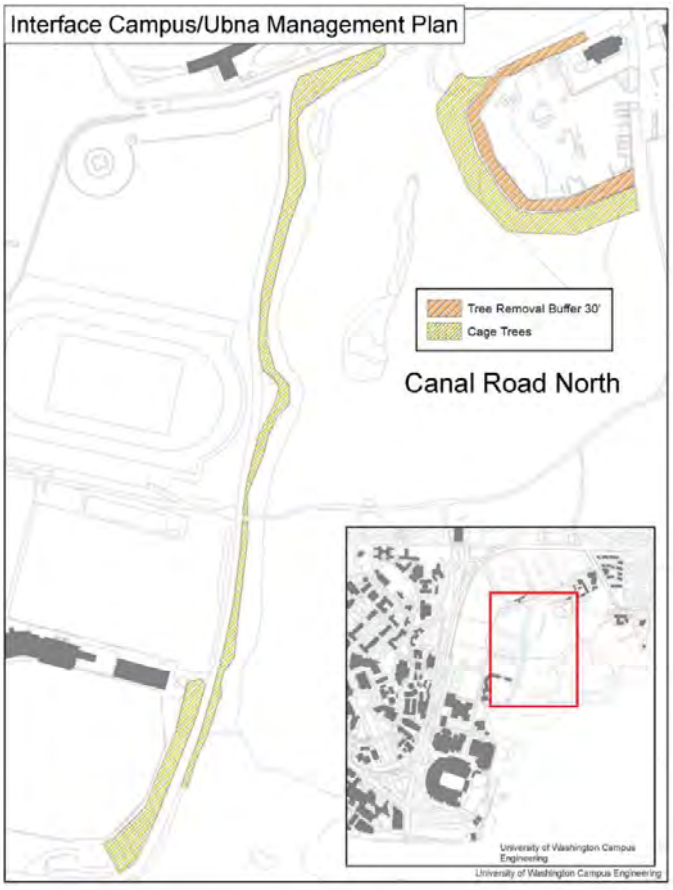
Betula nigra
Betula nigra 'Heritage'
Betula lenta

Beavers

RIPARIAN TREES | CURRENT PROBLEM

The North American Beaver, *Castor canadensis*, is a species that the University is fortunate to have in its wetland environments. Beavers provide important ecological functions as keystone species. Beavers are part of the wildlife that can be spotted at the Union Bay Natural Area on East Campus.

However, beavers provide unique challenges to the managment of the campus urban forest. The University maintains a Waterfront Tree Risk Mitigation plan to monitor and manage the trees within areas of known beaver activity. The goal of the plan is to reduce risk by creating a 30 foot buffer area around critical areas and cage all trees above 10 inches in DSH in those areas. All trees should be removed within 30 feet of roadways and structures in the critical area to prevent beaver-felled trees from posing a threat to people or buildings. Tree cages are wire mesh placed around the base of trees and are meant to prevent beavers from harvesting them. The plan is a cooperation between UW Grounds and the Center for Urban Horticulture.




4
NATIONAL

Stewardship Practices & Standards

The death of the forest is

the end of our life

Dorothy Stang

The University of Washington takes great pride in our ability to maintain and enhance the urban forest. Through the oversight of the University Landscape Architect and Facility Services Manager, and tree management being conducted by the University Arborist with assistance from grounds management crews, each tree and grove is carefully managed to minimize tree loss and improve tree health while enhancing the overall aesthetic of campus. Having acquired the title of Tree Campus USA in 2010 the University has continually added to the urban forestry program by establishing an Urban Tree Committee and partnering with students and faculty in tree plantings events and restoration projects. In addition, the University has established a tree salvage program that has grown in stature since its inception with the purchase of a kiln, sawmill, and other lumber processing equipment. This management structure is paired with a multi-layered design review process that works with planners, architects, engineers, landscape architects, and construction managers to preserve trees on campus when possible and to promote tree replacement. These processes along with management guidelines are outlined in this chapter to provide designers and builders with the University's tree planting standards.

Tree Campus USA

Since 2010, the University of Washington has held the proud distinction of Tree Campus USA. Tree Campus USA recognizes excellence in campus tree management that also engages both the student body and the wider community in the establishment and maintenance of community forests.

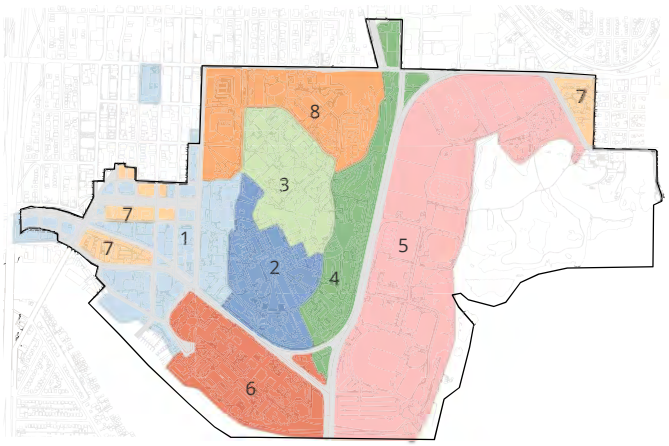
Tree Campus USA is a national program created in 2008 to honor colleges and universities for effective campus forest management and for engaging staff and students in conservation goals. The University of Washington achieved the title by meeting Tree Campus USA's five standards, which include:

- **Maintaining a tree advisory committee,**
- **Having a campus tree-care plan,**
- **Dedicated annual expenditures toward trees**
- **Arbor Day observance**
- **Annual Student service-learning projects**

Each year the University of Washington holds an annual planting event that engages students and staff in enhancing an area of campus that could use some additional care. Each event is designed to empower participants by allowing them to gain ownership of the landscape through their active engagement in maintaining and enhancing its legacy.

UW Grounds Management

The character of the landscape is a product of the careful work of UW Grounds. UW Grounds conducts all maintenance of trees, native areas, lawns, beds, and hardscape along sidewalks, vegetated areas, and parking lots within the Major Institutional Overlay. UW Grounds is a division of UW Facilities that consists of an Urban Forest Specialist, and crews for mowing, irrigation, and landscaping. The campus is divided into eight maintenance zones for different crews to individually manage. All trees on campus are managed by the University Urban Forest Specialist with support from third-party arborists.



GROUNDS CREWS

As manager of all property within the Major Institutional Overlay the University has a highly trained staff of landscape managers, arborists, and irrigation crews that maintain the campus to a high standard of care. Each maintenance zone consists of one lead with the support of 2 - 4 gardeners.

URBAN FOREST SPECIALIST

The University has a full time Urban Forest Specialist on staff that manages all trees on campus with the assistance of an aid. The Urban Forest Specialist conducts all tree pruning, removal, tagging, inoculations, mulching, and staking. During construction projects the University uses a third-party arborist to conduct a tree analysis for each site to provide recommendations with regards to existing trees on the site. The Campus Architecture & Planning group works closely with the Urban Forest Specialist to maintain the vibrancy of the University's urban forest.

CAMPUS TREE ADVISORY COMMITTEE

To provide additional oversight and as a requirement of being a Tree Campus USA, a tree advisory committee has been established to facilitate an open dialogue amongst the various stakeholders of the urban forest: Facility Services Manager, Urban Forest Specialist, Arboretum Manager, Integrated Pest Management Lead, Center for Urban Horticulture Staff and University Landscape Architect. They meet once a year to discuss concerns related to protecting and replanting trees that are impacted by construction activities and natural disturbances. This committee offered valuable guidance in the creation of this document through content recommendations and oversight.

Plan Integration

The urban forest is constantly changing and evolving making accurate monitoring critical. Additionally, strategic outreach and partnerships can help create a greater awareness of the value of the urban forest resource at the University and grow its educational benefit and opportunities for research.

Promote awareness of UW's urban forestry activities & resources

The urban forestry program has implemented numerous activities to strengthen the value of the campus urban forest to the public that could benefit from greater awareness.

CREATE ONLINE RESOURCES INCLUDING:

1. On-campus activities happening associated with the campus urban forest.
2. Content associated with the wood salvage program.
3. Student-led restoration projects.
4. Engagement campaign around Arbor Day (last Friday of April) to promote recent activities.
5. Educational curriculum for the classroom and the public.

BENEFITS

1. Shares the value of management work already done.
2. Eases access to urban forestry information.
3. Standardize outreach materials for forestry activities.
4. Facilitates grant writing information needs.

Maintain an up-to-date GIS Tree Database

The University surveyed the trees on campus in 2005. The initial effort documented 85% of campus trees in a database. Since then, substantial construction has taken place on campus changing the forest's structure on campus. Completing the survey and keeping the database up to date will allow the University to monitor how the urban forest is changing on a tree-by-tree basis.

OPPORTUNITIES

1. Identify the cost for completing the tree survey in non-surveyed areas identified in this document.
2. Update the tree database when projects on campus occur.
3. Identify different funding sources for completing tree database tasks.
4. Complete a comprehensive update to the tree database focusing on tree health condition.
5. Explore the value of aligning UW's tree database with iTrees standard to evaluate ecosystem services data.

BENEFITS

1. Used to identify existing trees located within the limit of work of construction sites.
2. Allows the university to track the changing diversity, age, and health of trees on campus.
3. Can be provided to the city to be used with their online tree maps.
4. Environmental value can be quantified with iTree formatted data.

Increase the diversity of trees on campus

A diversity of tree age, type, and size should be intermixed throughout campus to maintain a resilient urban forest in the face of climate change. Species diversity and richness will help protect the University's urban forest from large infestations and massive tree death associated with warmer, dryer summers. Diversifying tree species will emphasize the campus urban forest as a learning resource and research opportunity for students, faculty, staff, and visitors.

OPPORTUNITIES

1. Develop standards for planting new trees of various ages and species on campus.
2. Work with grounds staff to identify locations on campus where new trees can be planted.
3. Create a planting palette for campus.
4. Create a Replacement Plan for aging and unhealthy trees on campus.
5. Strengthen the discussion related to tree plantings during the design process of projects.
6. Identify funding sources to plant additional trees on campus.
7. Build upon the successes of student lead restoration projects to increase their occurrence on campus.
8. Periodically revise the tree replacement policy for trees removed due to construction.

BENEFITS

1. Helps build a resilient urban landscape.
2. Builds upon the University's goal of turning the landscape into a "Living Laboratory."
3. Strengthens the cultural value that the forest adds to the University.
4. Enhances wildlife habitat on campus.
5. Different tree types can be leveraged for their environmental services resulting in utility cost savings.

Improve the health of trees on campus

The University's urban forest could benefit from management that improves the health of each tree. Implementing a strategy for improving the health of existing trees can minimize costs associated with tree removal and maintenance.

OPPORTUNITIES

1. Identify all trees on campus that are in fair, poor, and very poor health.
2. Create best management practices for improving tree condition.
3. Develop a means for conducting additional tree maintenance on unhealthy trees.
4. Monitor new tree plantings on campus to identify issues with specific sites and conditions.
5. Implement the prescribed a strategy for protecting trees from deadly bugs and disease.
6. Explore project opportunities with the Green Seattle Partnership, Campus Sustainability Fund, and EarthCorps.

BENEFITS

1. Protect mature trees, which ensure the greatest ecosystem services, and ensure other trees reach maturity.
2. Helps protect the cultural value of trees on campus.
3. Helps to minimize maintenance and operation costs.

Support the campus as a "Living Laboratory"

A goal of the University of Washington is to utilize its landscape as an extension of the classroom, turning it into a "Living Laboratory." This goal can benefit both students and faculty using a learning by doing approach. This would produce information of value to academics and university staff. An academic focus in urban forestry will support research and grow the knowledge base of the field.

OPPORTUNITIES

1. Support student research projects and capstone projects.
2. Provide access to the tree database for approved student projects.
3. Explore partnerships with restoration organizations such as Green Seattle Partnership, EarthCorps, and others.
4. Consider using the campus to plant unique trees from southern hardiness zones to test climate change impacts.
5. Identify faculty that have an interest in the topic of Urban Forestry.
6. Talk with local urban forestry managers about educational needs and opportunities.
7. Meet with academic departments that focus on the natural environment about administering the program.
8. Work with the Center of Urban Horticulture on establishing an urban forestry focus.
9. Collect support from the academic and professional community.
10. Identify opportunities for funding the creation of a new program.
11. Partner with the City of Seattle to define urban forestry research topics of interest to both parties.

BENEFITS

1. Promotes experiential learning on campus.
2. Gives students the opportunity to gain greater ownership of the campus landscape through projects.
3. Supports academic goals of the campus.
4. Can provide valuable data to the University for planning and management.
5. Grows the academic options available to students.
6. Promotes additional job opportunities for students during and post school.
7. Builds upon literature relevent to urban forestry.
8. Establishes an in-house resource for urban forestry researchers.
9. Has the potential to provide support to surveying activities and tree database maintenance.

Design Process

CONCEPT | SCHEMATIC | DETAILS | CONSTRUCTION

The University has established a robust design review process from a project's inception to completion that promotes dialogue between designers, the University community, and project stakeholders. The goal of this process is to align every project with the University's goals for preserving significant vegetated conditions, maximizing a building's function and capacity while enhancing the overall experience of the University. Every major project must go through this process, so the campus is developed and designed with buy-in from all stakeholders and considered as part of an integrated

PRE-CONSTRUCTION

At the start of every project, trees potentially impacted by the project are assessed. Capital projects require the University to hire a third-party Arborist to assess all trees within the construction area. Smaller projects will be assessed by the University Landscape Architect and University Arborist. An assessment of current conditions and an appraisal of each tree using the Trunk Formula Method is prepared. Tree protection is a high priority, and the University uses every measure to protect the root system and canopy of these trees. For more details into the University's standards, see the "Design Guidelines" section at the end of this chapter.

DESIGN REVIEW

All major projects are required to present to the University of Washington Architectural Commission for review and comment during all phases of the design process.

University of Washington Architectural Commission (UWAC)

UWAC was established in 1957 to advise the University President and Board on issues related to design, function, performance, and environmental integrity associated with new construction and planning on campus. The commission provides project review for development that affects the aesthetic character and composition of the university's campuses. The UWAC plays a key role in helping to preserve and enhance the unique character of outdoor spaces and attain high quality campus environments through reviewing and providing comments on construction projects on campus. The committee is made up of a diverse mix of members that have specific interest and expertise in topics directly related to landscape architecture, botany, urban design, campus planning, public health, and architecture.

DURING CONSTRUCTION

Once construction begins, the University Arborist, University Landscape Architect, and consulting Landscape Architect conduct site visits, nursery visits, and observes the installation of vegetation for each project. The collaboration within this group makes sure that the design intent is being fully realized while taking into consideration the maintenance requirements and the long-term vision of the landscape. Outside arborists may be brought in for various circumstances.

POST CONSTRUCTION

After construction has been completed, the campus Arborist conducts all tree management work during the warranty period of the contract.

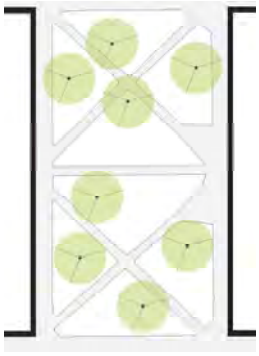
Design Considerations

Trees are used within the landscape to provide different experiences for students, faculty, staff, and visitors as they navigate the campus. Each of the tree design strategies below highlights the experiential quality trees are currently performing from enclosing a space to acting as a landmark in the landscape. These conditions are not limited to a single mosaic but range a breath of contexts which makes the campus experientially exciting when moving within and through the different neighborhoods. By using these strategies in areas where trees do not exist, it can help connect disparate areas of campus into a seamless and dynamic whole.

Informal

Within many of the lawns of campus, trees are placed into the landscape with no immediate visual order. Denny Lawn and Parrington Lawn are examples of this condition.

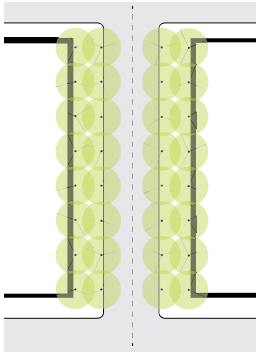
Campus Green, Informal Green



Formal

Tree allées are used on campus to provide ceremonial paths of travel through the campus. They support way finding by helping guide the public into the campus along the major paths of travel.

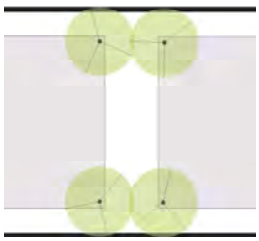
Passage



Frame

Trees can mark the transition between spaces on campus by framing a threshold or vista. Placing two trees at an intersection can help frame important landmarks or mixing zones.

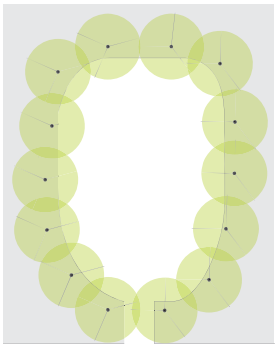
Campus Green, Plaza, Threshold, Garden



Enclosure

Some of the most memorable places on campus like Grieg Garden and Sylvan Grove are enclosed by trees which remove it from the surrounding context.

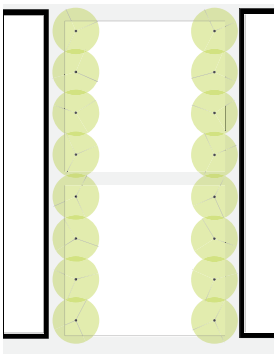
Garden, Courtyard/Terraces



Edge

Trees are commonly used on campus to define the edge of paths, landscapes, and open space or to buffer pedestrians from infrastructure.

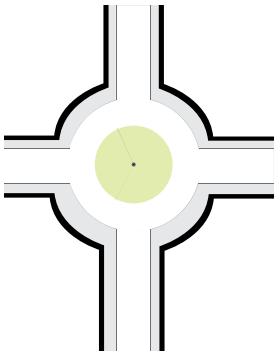
Urban Frontage, Passage, Service and Parking, Campus Green



Landmark

To highlight specific exceptional trees on campus, they have been isolated in the landscape to emphasize their grandeur. These trees require additional management to maintain their vigor.

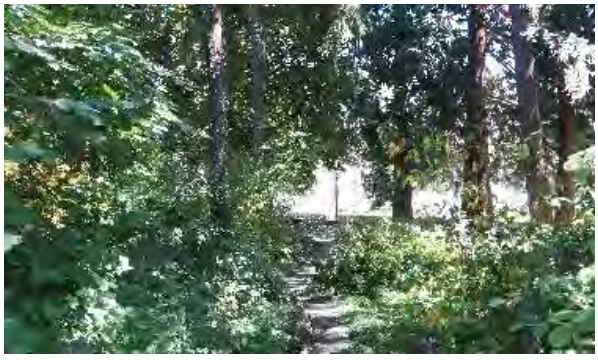
Plaza, Informal Green, Campus Green

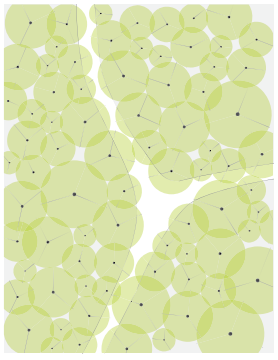


Native

Along the edges of campus and within corridors exists dense groves of trees with a robust under-story that have been preserved and maintained to provide examples of native northwest forests.

Woodland Grove, Meadow, Lake Edge Wetland





Design Guidelines & Standards

The preservation and enhancement of a healthy university landscape and urban forest begins with defining project goals and guidelines through the design and construction process. To establish a standard for landscape implementation, the University has defined critical design guidelines for consultants to use for creating landscapes that will thrive on the property and for groundskeepers to maintain and replace as necessary. These guidelines provide support from initial site planning to final acceptance. Within the following pages, details are provided to support specific guidelines or standards to be used by designers in the creation of construction documents. They include site planning, tree and plant protection, tree removal, and tree replacement.

For additional standards and specifications, the University requires use of the UW Facilities Design Standards including, but not limited to:

Plants standard specifications – including quality assurance; delivery, storage, and handling; site conditions; sequencing; warranty; site preparation; installation; maintenance; cleaning; protection.

Trees standard specifications – including contractor responsibility; preconstruction conference; quality assurance; tree protection; soil and compaction protection; site examination and coordination; pruning; tree and stump removal; fertilizing and irrigation during construction and maintenance period; damage or loss mitigation.

Irrigation design standards – including design evaluation; submittals; products, materials, and equipment; installation, fabrication and construction; drawings specifications.

Each specification is updated and maintained on the UW Facilities website: facilities.uw.edu/planning/design-standard

SITE PLANNING

- Meetings with the University Landscape Architect are encouraged prior to starting the design process.
- An evaluation of the existing trees on a site is required prior to design. This evaluation will be conducted by a third-party Arborist for all projects.
- All Tier 2 trees, trees to remain on site and trees for removal will be denoted on the site plan, demolition plan, and tree protection plan.
- A site survey is required for all new projects on campus, conducted by a licensed surveyor. An electronic AutoCAD version of the survey is to be provided to Campus Engineering when completed.

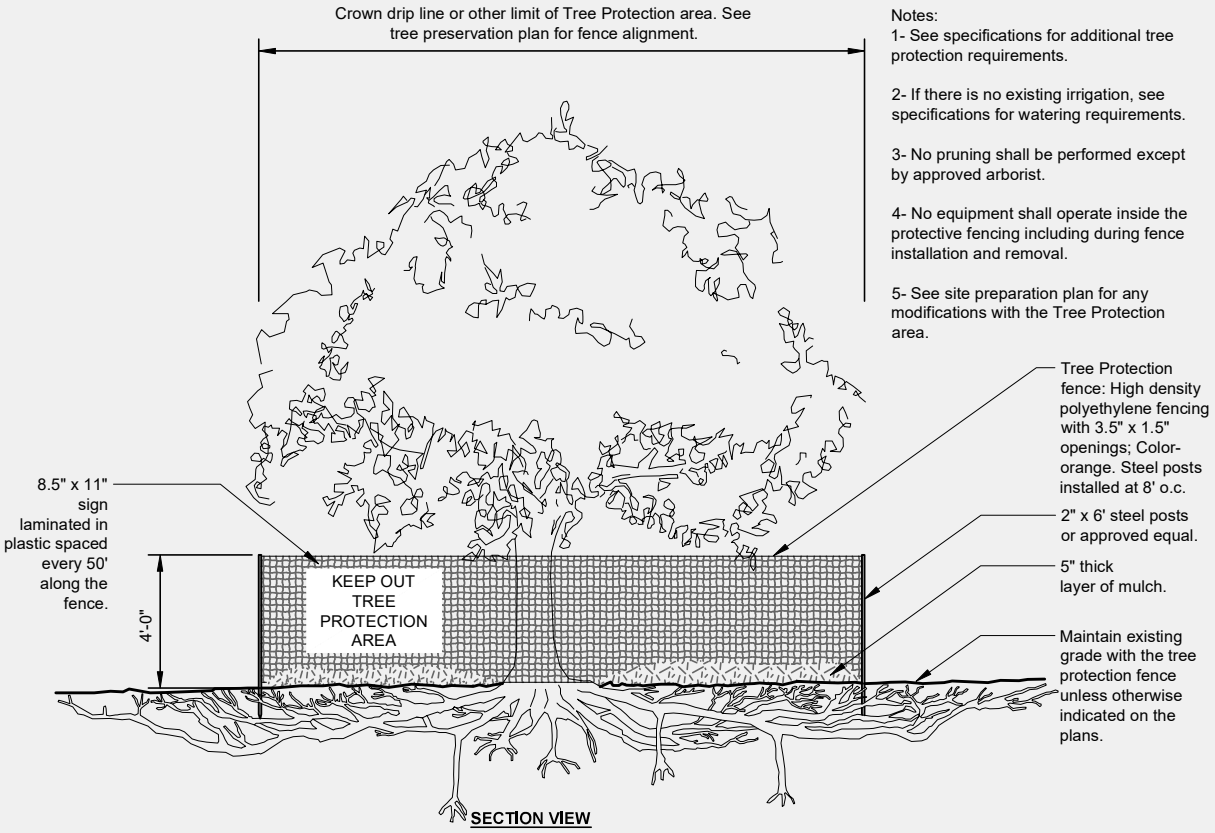
TREE PROTECTION PRODUCTS

- Tree Protection shall be reviewed and approved by the project Arborist or the University Landscape Architect prior to installation.
    - PROTECTION FENCING shall be equal to the following:
        - CHAIN LINK FENCE: 6 feet tall Galvanized, 11 gauge, 2 inch mesh chain link fencing with nominal 2 1/2 inch diameter galvanized steel posts set in metal frame panels on movable core drilled concrete blocks of sufficient size to hold the fence erect in areas of existing paving to remain.
        - GATES: For each fence type and in each separate fenced area, provide a minimum of one 3 foot wide gate. Gates shall be lockable. The location of the gates shall be approved by the University Landscape Architect.
        - Submit suppliers product data that product meets the requirements for approval.
    - MATTING shall be equal to the following:
        - Matting for vehicle and work protection shall be heavy duty matting designed for vehicle loading over tree roots.
        - Submit suppliers product data that product meets the requirements for approval.
    - GEOGRID shall be equal to the following:
        - Geogrid shall be woven polyester fabric with PVC coating, Uni-axial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, acids.
        - Submit suppliers product data that product meets the requirements for approval.
    - FILTER FABRIC shall be equal to the following:
        - Filter Fabric shall be non-woven polypropylene fibers, inert to biological degradation and resistant of naturally occurring chemicals, alkalis and acids.
        - Submit suppliers product data that product meets the requirements for approval.
    - PROTECTIVE SIGNAGE shall be equal to the following:
        - Contractor shall post weather-resistant 8.5”x11” fluorescent green or yellow signage on protection fencing at 20 foot intervals warning construction personnel to keep out of tree protection zones.

TREE AND PLANT PROTECTION AREA

- The Tree and Plant Protection Area is defined as all areas indicated on the tree protection plan. Where no limit of the Tree and Plant Protection area is defined on the drawings, the limit shall be the drip line (outer edge of the branch crown) of each tree.
- The Contractor shall not engage in any construction activity, traverse the area to access adjacent areas of the project, or use the Tree Protection area for lunch or any other work breaks without the approval of the University Landscape Architect.

- All tree management activities within the Tree Protection Area will be performed or observed by a Certified Arborist.
- Potentially harmful materials to tree roots can not be stored within twenty (20) feet of protection fencing. Potentially harmful materials include, but are not limited to, petroleum products, cement and concrete materials, cement additives, lime, paints and coatings, waterproofing products, concrete forms coatings, detergents, acids, and cleaning agents.
- Flag all trees and shrubs to be removed by wrapping orange plastic ribbon around the trunk and obtain the University Landscape Architect's approval of all trees and shrubs to be removed prior to the start of tree and shrub removal. After approval, mark all trees and shrubs to be removed with orange paint in a band completely around the base of the tree or shrub 4.5 feet above the ground.
- Flag all trees and shrubs to remain with white plastic ribbon tied completely around the trunk or each tree and on a prominent branch for each shrub. Obtain the University Landscape Architect's approval of all trees and shrubs to be remain prior to the start of tree and shrub removal.
- Prior to any construction activity at the site including utility work, grading, storage of materials, or installation of temporary construction facilities, install all tree protection fencing, Filter Fabric, silt fence, tree protection signs, Geogrid, Mulch and or Wood Chip.



S-X TREE PROTECTION

URBAN TREE FOUNDATION © 2014
OPEN SOURCE FREE TO USE

TREE AND PLANT PROTECTION AREA CONT.

- All trees and landscape requiring protection shall be fertilized and watered by the Contractor until Substantial Completion.
- In the event that construction activity is unavoidable within the Tree and Plant Protection Area, notify the University Landscape Architect and submit a detailed written plan of action for approval. The plan shall include: a statement detailing the reason for the activity including why other areas are not suited; a description of the proposed activity; the time period for the activity, and a list of remedial actions that will reduce the impact on the Tree and Plant Protection Area from the activity. Remedial actions shall include but shall not be limited to the following:
    - When excavation for new construction is required within the Tree Protection Area, hand clear and excavate in a matter that will not cause damage to the tree, roots or soil.
    - Tree branches that interfere with the construction may be tied back or pruned to clear only to the point necessary to complete the work. Other branches shall only be removed when specifically indicated by the University Landscape Architect.

TREE REMOVAL

- Trees are to not be dropped with a single cut unless the tree will fall in an area not included in the Tree and Plant Protection Area. No tree to be removed within 50 feet of the Tree and Plant Protection Area shall be pushed over or up-rooted using a piece of grading equipment.
- Protect adjacent paving, soil, trees, shrubs, ground cover plantings and understory plants to remain from damage during all tree removal operations, and from construction operations. Protection shall include the root system, trunk, limbs, and crown from breakage or scarring, and the soil from compaction.
- Grind stumps to ground level, unless there are roots from other trees or vegetation that may be negatively impacted by the practice.
- Prior to tree removal, work with the University Landscape Architect on potentially salvaging the lumber produced from the removed tree.

TREE REPLACEMENT

- The requirement for Tier 2 tree replacement is a 2:1 ratio of trees lost to trees required. All other trees are required to be raplaced at a ratio of 1:1. New trees shall be 2" in caliper minimum. **Trees shall have a replacement value of $1,000/tree.**
- When the project cannot replace all trees that were identified for preservation on-site or if damaged by construction, the equivalent value of these trees will be charged to the project. The cost to the contractor is based upon the square inches of cross sectional area of trunk measured at 4 ft. above grade, in accordance with the following criteria:
    - $75.00/square inch for trees less than or equal to 6 inch diameter
    - $50.00/square inch for trees greater than 6 inch and less than 18 inch diameter
    - $40.00/square inch for trees greater than or equal to 18 inch diameter

BIBLIOGRAPHY

The following resources were used in the creation of this document.

"About the Emerald Ash Borer." Emerald Ash Borer Network, Michigan State University Department of Entomology, www.emeraldashborer.info/about-eab. Accessed 29 Aug. 2023.

Charnley, Susan, et al. "Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest." Forest Ecology and Management, vol. 246, no. 1, 16 July 2007, pp. 14–28, https://doi.org/10.1016/j.foreco.2007.03.047.

Donovan, G. H., & Prestemon, J. P. (n.d.). The Effect of Trees on Crime in Portland, Oregon. Environment and Behavior, 44(1), 3–30. http://doi.org/10.1177/0013916510383238

Dulude, Lisa. "Sustainability Update." UW Sustainability, 09 November 2023, Seattle, WA. Address to the University of Washington Board of Regents.

Donovan, G. H., Butry, D. T., Michael, Y. L., Prestemon, J. P., Liebhold, A. M., Gatziolis, D., & Mao, M. Y. (2013). The relationship between trees and human health: Evidence from the spread of the emerald ash borer. American Journal of Preventive Medicine. http://doi.org/10.1016/j.amepre.2012.09.066

Gibbons, K. H., Ryan, C., Bradley, G., & Perez, M. (2014). A Framework for Developing and Evaluating Comprehensive Urban Forest Management Plans: An Analysis of Washington State Plans. University of Washington.

"Green Stormwater Infrastructure in Seattle: Implementation Strategy 2015-2020." Seattle Public Utilities. https://www.seattle.gov/documents/departments/ose/gsi_strategy_nov_2015.pdf. Accessed 15 Dec. 2023.

"Harvest Statistics." Washington Department of Revenue, 2022, dor.wa.gov/taxes-rates/other-taxes/forest-tax/harvest-statistics.

"i-Tree Ecosystem Analysis: UW Campus Urban Forest Benefits." i-Tree Eco, United States Department of Agriculture, 2023.

Jackson, D. "Landscaping Projects Improve Campus Appearance." The University of Iowa Facilities Services Group, June 2002, https://olemiss.edu/depts/landscape/iowa.html.

Kaplan, S. (1995). The Restorative Benefits of Nature: Toward an Integrative Framework. Journal of Environmental Psychology, 15, 169–182.

"NAID: 298856." National Archives Catalog, 25 Nov. 1917, https://catalog.archives.gov/id/298856. Accessed 29 Aug. 2023.

Nowak, David j, et al. Sustaining America's Sustaining America's Urban Trees and Forests, US Department of Agriculture, June 2010, www.fs.usda.gov/nrs/pubs/gtr/gtr_nrs62.pdf.

BIBLIOGRAPHY CONT.

Palmer, Marin, et al. "Washington's Forest Resources, 2007–2016: 10-Year Forest Inventory and Analysis Report." US Forest Service Research and Development, 1 May 2019, www.fs.usda.gov/research/treesearch/58048.

"The Effects of Trees on Stormwater Runoff." Herrera Environmental Consultants, Inc., 14 Feburary 2008.

"USDA Plant Hardiness Zone Map." USDA Plant Hardiness Zone Map, planthardiness.ars.usda.gov/. Accessed 29 Aug. 2023.

"2020 Urban Forest Management Plan." Seattle.Gov, Trees for Seattle, www.seattle.gov/Documents/Departments/Trees/Mangement/UrbanForestManagementPlanFinal.pdf. Accessed 29 Aug. 2023.

"2021 City of Seattle Tree Canopy Assessment: Final Report." Office of Sustainability & Environment. https://seattle.gov/documents/Departments/OSE/Urban%20Forestry/2021%20Tree%20Canopy%20Assessment%20Report_FINAL_230227.pdf. Accessed 10 July 2023.

Revised in 2024

Contributors:

Griffin Cronk, MLA Candidate

Julie Blakeslee, University Environmental and Land Use Planner

Kristine Kenney, Director of Campus Architecture & Planning

Sara Shores, Urban Forest Specialist

Revised using City of Seattle LiDAR data from 2021 and UW Tree Inventory data through 2023

First published in 2016

Contributors:

Patrick Pirtle, MLA

Kristine Kenney, Director of Campus Architecture & Planning

Written using LiDAR data from 2003 and tree assessment data from 2015