CITY OF SEATTLE

RESOLUTION _____

A RESOLUTION adopting the 2013 update of the Urban Forest Stewardship Plan.

WHEREAS, urban forests provide residents with environmental benefits by performing natural functions including retaining storm water runoff, cleaning the air and water, providing wildlife habitat and sequestering carbon; and

WHEREAS, a healthy urban forest enhances the quality of life in Seattle by creating green places for people to live, work, and play; and

WHEREAS, research has shown that urban forests provide economic benefits such as increasing property values, office occupancy rates, and shopping frequency, as well as lowering crime rates and health care costs; and

WHEREAS, the Mayor and City Council appreciate the value of a healthy and growing urban forest for the benefit of current and future generations of residents; and

WHEREAS, in 2007, the City developed the Urban Forest Management Plan ("Plan") to preserve and enhance the urban forest and established a 30-year goal of achieving 30 percent canopy cover across the city and laid out a schedule of updating the Plan every five years; and

WHEREAS, the goals and strategies in the Plan provide the guiding framework for City departments' work plans and the Urban Forestry Commission's work plan and recommendations; and

WHEREAS, the City's Urban Forest Interdepartmental Team worked closely with the Urban Forestry Commission in the 2013 update of the Plan; and

WHEREAS, the 2013 update of the Plan was informed by the most up-to-date findings on the state of Seattle's urban forest; and

WHEREAS, the Department of Planning and Development has performed SEPA review and published a threshold determination of non-significance; and

WHEREAS, community input on the Plan was solicited through a 12 week public comment period in the summer of 2012; and

WHEREAS, through Council input it was determined that changing the Plan's title to Urban Forest Stewardship Plan would more clearly convey the importance of engaging residents, organizations, along with City staff in the care of Seattle's urban forest;

NOW, THEREFORE,

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF SEATTLE, THE MAYOR CONCURRING, THAT:

Section 1. The 2013 update of the Urban Forest Stewardship Plan, which is attached hereto as Attachment A, is hereby adopted as the City's framework to preserve and enhance Seattle's urban forest.

Adopted by the City Council the ____ day of _____, 2013, and signed by me in open session in authentication of its adoption this_____ day of _____, 2013.

_____

President Sally J. Clark of the City Council

THE MAYOR CONCURRING:

_____

Michael McGinn, Mayor

Filed by me this ____ day of _____, 2013.

_____

Monica Martinez Simmons, City Clerk

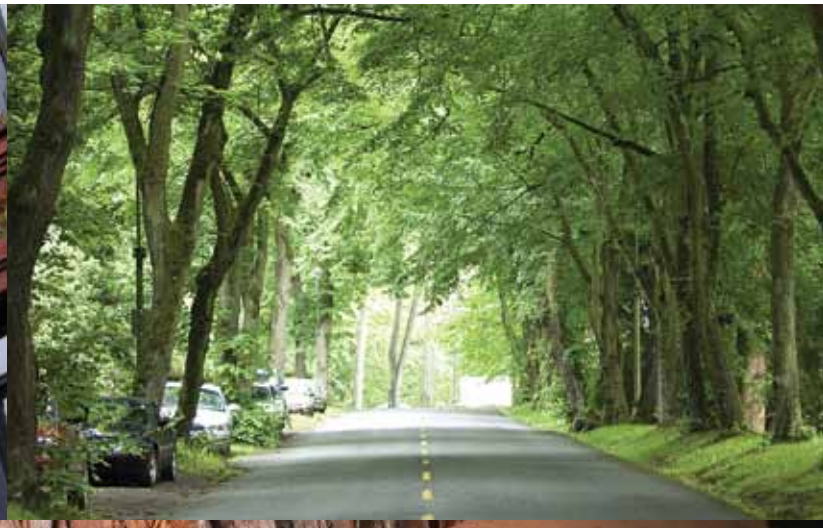
(Seal)

Attachment:

Attachment A: 2013 Urban Forest Stewardship Plan Update

City of Seattle

2013 URBAN FOREST STEWARDSHIP PLAN



Vision Statement:

Seattle's urban forest is a thriving and sustainable mix of tree and understory species and ages that creates a contiguous and healthy ecosystem that is valued and cared for by the City and all of its residents as an essential environmental, economic, and shared community asset that reinforces Seattle's identity and legacy as a forested, livable city.

Acknowledgements

The City of Seattle is thankful to all the people that contributed to the 2013 Urban Forest Stewardship Plan.

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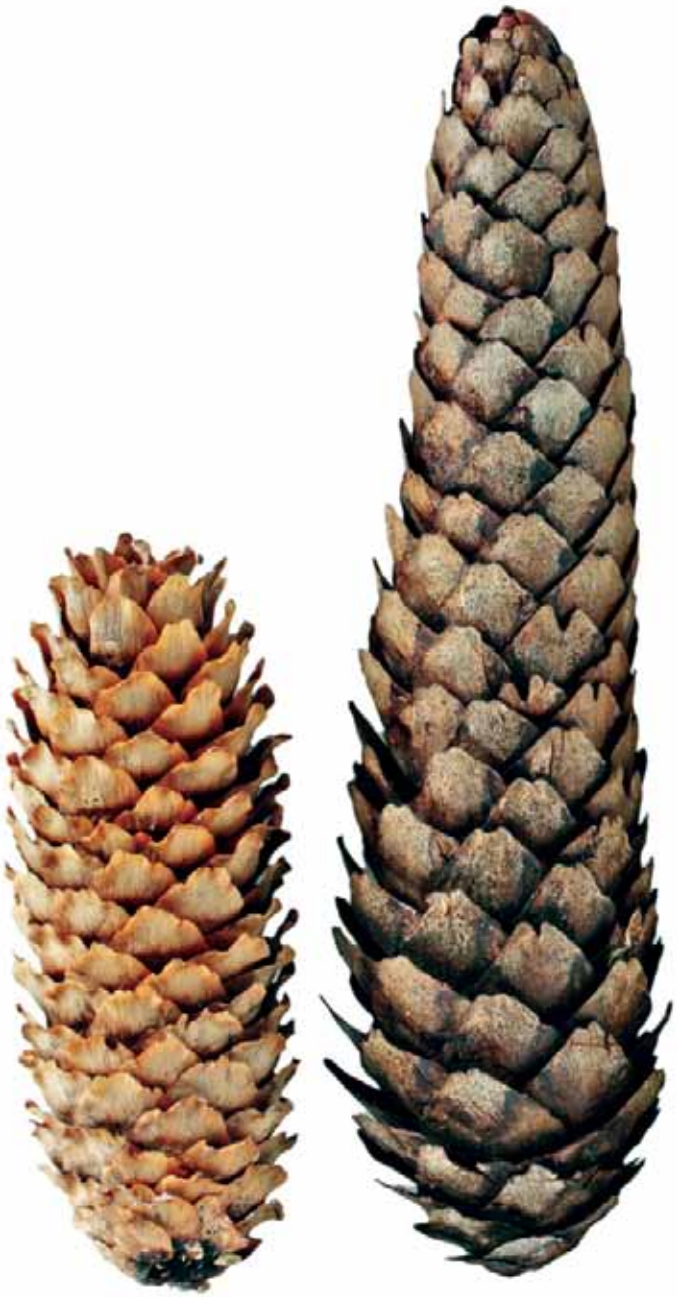

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EXECUTIVE SUMMARY

URBAN FOREST STEWARDSHIP PLAN

Our trees create beautiful views in their own right, and frame views of our other natural wonders.

Trees are an essential part of our city. A healthy urban forest provides benefits including air and water pollution mitigation, habitat for wildlife, and storm water runoff reduction. Trees are fundamental to the character of Seattle—a city that celebrates its reputation as one of the country's greenest cities. Our trees create beautiful views in their own right, and frame views of our other natural wonders, such as Mount Rainier, the Cascade and Olympic mountain ranges, Puget Sound, and our magnificent lakes.

Studies have shown that trees in a neighborhood contribute to community involvement and have positive health benefits—ranging from asthma relief, improved academic performance, and shorter recovery times for patients.

But Seattle's trees do not simply grow untended. Although the landscape that makes up Seattle today is naturally heavily wooded, most of the original trees were clear-cut by the late 1800s. Seattle's existing urban forest is mostly human-made—and requires active stewardship to remain healthy.

Chapter 1 – The Purpose of the Plan

The City recognizes the value and benefits of the urban forest, and the need for an integrated and adaptive approach to hands-on maintenance and caring of our trees. To address the needs of Seattle's urban forest, the City introduced the Urban Forest Management Plan in 2007 as a guiding document for action. This 30-year plan set a goal of increasing Seattle's canopy cover to 30 percent by 2037 and created a framework for City departments, non-profit organizations, residents, and the community as a whole to support efforts to maintain the urban forest.

To clearly convey the importance of engaging Seattle residents and organizations along with City staff in the care of our urban forest, the term stewardship was incorporated into the plan's title. The 2013 Urban Forest Stewardship Plan is the first comprehensive update to the 2007 Plan.

The 2013 Plan is organized in six sections, which look at the Plan's guiding principles and integrated approach, the importance of Seattle's urban

City of Seattle

Public as well as City government engagement is essential to our ability to realize the vision of Seattle's urban forest. It is important for the nature of this engagement to be grounded in an ethic of environmental stewardship.

forest, the current condition of Seattle's urban forest, current stewardship and management efforts, goals and actions for moving forward, and future research and assessment needs.

Guiding Principles

The Plan is based on the premise that our urban forest is something worth caring for and that the actions we take as humans are significant, but are only part of many influences that affect the maintenance of a healthy urban forest.

In order to meet our long-term goals, we must recognize that we are faced with an adaptive challenge that requires individuals, communities, and institutions to change their values, behavior, and their attitudes about urban trees. Public as well as City government engagement is essential to our ability to realize the vision of Seattle's urban forest. It is important for the nature of this engagement to be grounded in an ethic of environmental stewardship.

The UFSP's concept of stewardship is based on an ecological framework that sees trees as a shared community resource and as part of the natural urban ecology, providing important environmental and social functions and services for Seattle and our natural environment. Our strategies are based on actions that contribute to the health and regeneration of the urban forest. Policies and programs will emphasize opportunities for creating public, private, and community partnerships and stewardship through outreach, information, regulations, incentives, and development of skills that promote long-term sustainability and positive outcomes.

The Plan's Integrated Approach

The ability to preserve, sustain, and regenerate our urban forest over time depends on actions taken by multiple City departments, community organizations, businesses, and individuals.

Community approach

The responsibility for sustaining the urban forest ultimately involves individual and neighborhood actions as well as governmental actions. Because the majority of trees exist on private land, community engagement and cooperation is vital to achieving the Plan's vision.

Ecological approach

Trees are not merely units to be accounted for, but are inherently part of a natural ecology. Collectively, trees are an essential element for human and ecological health through the environmental and social functions and services they provide.

Resource management approach

The policy, planning, and resources brought to bear on the urban forest resource comprise the management framework. The UFSP has adapted the Clark et al's (1997) sustainability model to provide a structure based on land use that organizes our goals and strategies and how City departments manage trees.

Chapter 2 - The Importance of Seattle's Urban Forest

In addition to providing beauty, shade, and views, the urban forest provides less obvious, but quantifiable, environmental, social, and economic benefits. The urban forest saves millions of dollars annually for the City and for residents by reducing energy use, sequestering carbon, and removing air pollution. Residents in treed neighborhoods report higher community involvement and lower stress levels.

The urban forest in Seattle has benefited from our city's legacy of interest and pride in its natural flora. In 1903, the City commissioned the Olmsted Brothers Landscape Architecture firm to create green spaces throughout Seattle, in the form of parks and treed boulevards. This effort began a long history of City support for the maintenance and protection of the urban forest. In this same spirit, the City has implemented numerous programs and incentives to keep Seattle green with trees and understory plants. This ongoing work and support has provided an excellent framework for maintaining and diversifying the urban forest.

Chapter 3 - Seattle's Urban Forest Today

There are currently between 1.6 million and 3 million trees in Seattle, and most of these trees were planted by human hands. Because understanding the make-up and breadth of the urban forest is vital to maintaining and enhancing that forest, the City has commissioned two canopy cover assessments, one in 2007 and the second one in 2009. According to the second canopy cover assessment, Seattle had a canopy cover of about 23 percent. Assessments also look at species diversity; age diversity; the health of trees, and the distribution of trees throughout nine management units (Single-Family Residential, Multi-Family Residential, Commercial/Mixed Use, Downtown, Industrial, Institutional, Developed Parks, Parks' Natural Areas, City-Wide, and Right-of-Way).

While the City has established a legacy of support for the urban forest, there are still areas where trees struggle within their environments. Trees compete for space with industry and development. They may be cut down for reasons that range from growing food to providing vistas to preventing hazards, such as when they interfere with power lines or block driving visibility.

Invasive species have played a detrimental role in Seattle's urban forest. Without intervention, within one hundred years our urban forest could be dominated by invasive species, with most trees and native vegetation gone. At this time, 70 percent of Seattle's urban forests have some invasive plants.

A native Northwest forest is typically made up of mostly evergreen with a small mix of deciduous trees. At this time, only 31 percent of the forest is made of evergreen trees, while 69 percent is made up of deciduous trees. Deciduous trees provide less shade and rainwater mitigation than do evergreen trees, which maintain their canopy year-round. Seattle's urban forest also lacks age and species diversity. Because so many of Seattle's trees were planted at beginning of the 20th century, many are reaching the end of their life spans.

Seattle's urban forest lacks age and species diversity. At this time, only 31 percent of the forest is made of evergreen trees, while 69 percent is made up of deciduous trees.

City of Seattle

Chapter 4 - Current Stewardship and Management Efforts

The broad appreciation that Seattle's trees enjoy has been a great benefit in establishing tree stewardship programs.

Within the City, there are eight departments with tree management responsibilities. The City also engages the community and non-profits in a variety of ways. Planning and policy development and outreach and engagement are vital to the success of City and community work in the area of tree management. Through these efforts, the City and residents come together to establish policy and execute tree management efforts. A number of non-profit organizations work with volunteers and with the City on behalf of Seattle's urban forest removing invasive species, planting trees, training residents in tree maintenance, and establishing Heritage Trees.

The City also manages trees on public land through planting, establishing, and maintaining trees, and managing woodwaste. While trees on private property are the responsibility of landowners, the City works to regulate and incentivize proper tree care and overall appreciation for the value and benefits they provide.

Chapter 5 - A Path Forward

The UFSP establishes four goals for Seattle's urban forest:

1. **Create an ethic of stewardship about the urban forest among City staff, community organizations, businesses, and residents**
2. **Strive to replace and enhance specific urban forest functions and benefits when trees are lost, and achieve a net increase in the urban forest functions and related environmental, economic, and social benefits**
3. **Expand canopy cover to 30 percent by 2037**
4. **Increase health and longevity of the urban forest by removing invasive species and improving species and age diversity**

To achieve these goals, the City has established a set of priority actions due to their importance related to forest functions and stewardship. These priorities will assist in providing overall policy and programmatic direction.

Priority Action: Preserve existing trees.

Because it takes decades for most trees to reach their ultimate size, trees already growing in Seattle generally provide immediate and ongoing benefits that cannot be matched by a small/young replacement tree. Exceptions may be trees planted in inappropriate places, hazardous, dead, or diseased trees that pose a risk to other trees.

Focus especially on:

Evergreen trees. Because they maintain their canopy during the rainy season and are active year-round, evergreens can better attenuate rainfall, absorb carbon dioxide, and reduce air pollutants. Evergreen trees also are longer-lived than deciduous trees and tend to have much greater size potential.

Mid-Large trees. Larger trees provide more environmental, cultural, and economic functions and benefits than smaller ones.

Forests, Woodlands, and Groves of Trees. Compared to an individual tree surrounded by pavement or grass, groups of trees provide increased benefits by offering recreational opportunities, providing more diverse wildlife habitat, and creating duff soils on the forest floor that absorb storm water. These trees are commonly associated with a multi-story canopy comprised of diverse species that provides more robust ecological functions than trees alone.

Unique Wildlife Habitat. Higher quality habitat areas, such as heron rookeries, eagle nests, and salmon-bearing waters, are difficult to replace and can be impossible to replicate.

Priority Action: Maintain existing trees.

The health of existing trees is supported through proper and timely pruning, removing invasive species, and, where appropriate, expanding soil volume to accommodate tree growth. Vigilant monitoring of tree pests is critical to early and effective eradication.

The success of our efforts is dependent upon informed actions and significant involvement by volunteers and residents.

Priority Action: Restore.

A thriving urban forest is one that is resilient to invasive species because every ecological niche is already occupied by native species. Efforts to remove invasive species and plant diverse, healthy forests plant communities are crucial for the wellbeing of our forested parklands and other open spaces.

Priority Action: Plant new trees.

Because trees age and die, urban forest regeneration requires replenishment of trees through human intervention. Active planting is needed to also ensure age and species diversity. In order for new trees to thrive, proper soil conditions, soil volume, appropriate location, water, and maintenance need to be provided. Consideration should be given to planting trees that maximize important functions and benefits, or replenish or enhance functions and benefits lost due to tree removal.

Priority Action: Increase awareness of the value and proper care of trees.

Urban forest stewardship requires the on-going engagement of government and the community. The success of our efforts is dependent upon informed actions and significant involvement by volunteers and residents.

Specific strategies have been established to reach these goals:

Inspire, inform, and engage the community in active stewardship of Seattle's urban forest.

Understand the characteristics and complexity of the urban forest resource;

Coordinate interdepartmental and interagency communication, cooperation, and decision-making;

Preserve, restore, and enhance the urban forest on City property; and

Regulate private property to ensure minimum standards for care of the urban forest.

An action agenda to support the goals and strategies has been outlined with three timelines: short-term (by 2018), mid-term (5 to 10 years out), and long-term (10 years or more). Different actions' feasibility, their role as part of the critical path, and their ability to show progress were taken into consideration while developing the timeframe for each action. Regular check-in points on the progress of plan implementation will be necessary to keep efforts on track.

A monitoring framework to address plan implementation, effectiveness, and performance, will be developed as part of the action agenda. Monitoring will be used to evaluate efforts and update the Plan to make actions even more effective and responsive over time. Indicators will be used to establish a baseline and track changes in forest function, extent, and health.

Implementation of the Plan's action agenda will require policy, program, and budget coordination, as well as long-term and stable funding.

Chapter 6 - Future Research Needs

As we move into the next phase of the Plan, there are several areas where additional research would benefit the health of our urban forest. The City proposes research into the following: life-cycle cost of deferred tree planting and maintenance; cost and benefit comparisons of different pruning cycles; monetizing forest benefits; quantifying storm water and water-quality benefits for for individual trees and trees in forested parklands; quantitative data on the benefits of trees as a race and social justice issue.

1 PURPOSE OF THE PLAN

CHAPTER 1

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Seattle's urban forest represents an invaluable asset for the City, providing ecological, economic, and social benefits. It helps define the character of the city, provides important habitat for wildlife, creates spaces for exploration and enjoyment, and acts as an important infrastructure element providing storm water and air pollution services. To clearly convey the importance of engaging Seattle residents and organizations along with City staff in the care of our urban forest, the term stewardship was incorporated into the plan's title.

The 2013 Urban Forest Stewardship Plan (UFSP) provides a policy framework that guides decision-making and identifies principles, priorities, goals, and strategies that will help Seattle preserve, protect, maintain, and restore its urban forest over the next 24 years. The Plan provides the foundation to direct and integrate management of the many issues and opportunities posed by Seattle's urban forest resources.

The Plan aims to identify actions that will support a healthy and regenerative urban forest across Seattle's public and privately owned lands through the combined efforts of City government, non-profit and business groups, and Seattle residents. This Plan reflects the current understanding of Seattle's urban forest conditions and forest management needs. However, it is intended to be a living document that is regularly updated.

This UFSP represents the first comprehensive update of the Plan (originally called the Urban Forest Management Plan), which was created in 2007.

Guiding Principles

The UFSP is based on the premise that our urban forest is something worth caring for and that the actions we take as humans are significant, but are only part of many influences that affect the maintenance of a healthy urban forest.

Strategic decisions and actions are required to sustain and expand our urban forest. These decisions about policies, programs, and actions are based on stakeholders' beliefs, attitudes, and knowledge of the issues, as well as challenges and opportunities specific to Seattle. The challenge facing policymakers and resource managers is that urban forest protection and regeneration cannot be accomplished only through policy and technical solutions such as the creation of rules and regulations or administrative actions that dictate pruning cycles or require permits. Regulations are one important tool but require consistent enforcement and face constraints given that 67 percent of Seattle's trees are on private property.

Definition of Seattle's Urban Forest

Seattle's urban forest consists of the trees and associated understory species that are found on public and private property within the city. This includes forested parks and natural areas, as well as the trees along streets and in yards. Seattle's trees support and are supported by broader ecosystem elements, such as understory plants, the watershed, soil conditions, and wildlife.

City of Seattle

In order to meet our long-term goals it is important to recognize that we are faced with an adaptive challenge that requires individuals, communities, and institutions to change their values, behavior, and their attitudes about urban trees.[1] Adaptive challenges require change in numerous places across organizational boundaries, and efforts need to focus on engaging the people responsible for the care of trees whether they are individuals, organizations, or City staff. Adaptive challenges require knowledge, innovation, and cooperation.

Public as well as City government engagement is essential to our ability to realize the vision of Seattle's urban forest. It is important for the nature of this engagement to be grounded in an ethic of environmental stewardship.

Adaptive challenges require change in numerous places across organizational boundaries, and efforts need to focus on engaging the people responsible for the care of trees whether they are individuals, organizations, or City staff.

The UFSP's concept of stewardship is based on an ecological framework that sees trees as part of the commons (shared community resource) and the natural urban ecology, providing important environmental, social, and economic functions and ecological services as an integral part of the urban infrastructure. Our strategies are based on actions that contribute to the health and regeneration of the urban forest. Where feasible, actions will strive to replace existing and essential ecological, economic, and social functions. Policies and programs will emphasize opportunities for creating City government and community partnerships and stewardship through outreach, information, regulations, incentives, and development of skills that promote long-term sustainability of effort and positive outcomes.

The following guiding principles will direct our approach and implementation strategies:

- Trees are part of natural ecological systems. We will align our priorities, goals, and actions as much as possible to support human intervention

[1] Heifetz, Ronald. Leadership without Easy Answers.1994. Harvard University.

and ecological conditions that sustain trees, regenerate the urban forest, and increase functional benefits and services over time.

- The health of an urban forest is determined by several factors including condition, age and species diversity, soil health and environment, location, presence of invasive species, and threats posed by disease and pathogens. Seattle is working toward increasing its urban forest's size (canopy cover) and improving its condition to achieve the highest possible level of health and diversity.
- Protection of higher quality habitats areas, such as heron rookeries, eagle nests, and salmon-bearing waters that are tree-dependent is important.
- Human stewardship and intervention is required to preserve, enhance, and regenerate a healthy urban forest, and this stewardship must be jointly shared by City government, community organizations, businesses, and Seattle residents.
- Ecology of place and the City's ability to connect best ecological practices to appropriate locations is important in the development of programs and policies.
- Coordination of efforts and a systems approach to management maximizes the impact of our actions.
- Trees are part of our cultural and social environment. Attitudes toward trees vary from people who have a deeply spiritual connection to those who perceive trees as a nuisance. This difference needs to be considered in the development of programs and policies.
- Government policies and programs will be focused on creating and supporting actions and behaviors that support long-term forest sustainability and stewardship.
- Regeneration of the urban forest and urban trees has an ecologically based time horizon and is a dynamic, on-going process. This needs to be taken into account in the development, evaluation and monitoring of programs and policies.

The Plan's Integrated Approach

The ability to preserve, sustain, and regenerate our urban forest over time depends on consistent actions taken by multiple City departments, community organizations, businesses, and individuals. Our strategies and approaches need to be adaptable and able to respond to changing conditions and the complexity of the urban forest and management programs that influence it. Seattle's UFSP is informed by an approach developed in "A Model of Urban Forest Sustainability" (Clark et al. 1997) [2] and updated in "Criteria and Indicators for Strategic Urban Forest Planning and Management" (Kenney et al. 2011) [3] . The Plan's action agenda will be guided by the following three interconnected approaches that will assist City government and the community in prioritizing and organizing efforts as well as monitoring our work.

Clark et al (1997) A Model of Urban Forest Sustainability

This model for the development of sustainable urban forests applies general principles of sustainability to urban trees and forests. The central idea is that sustainable urban forests require a healthy tree and forest resource, community-wide support, and a comprehensive management approach. The most important outcome of a sustainable urban forest is to maintain a maximum level of net environmental, ecological, social, and economic benefits over time. The model recognizes the challenges, benefits, and opportunities unique to city trees and establishes criteria and indicators for assessing progress toward goals at a given point in time.

Kenney et al (2011) Criteria and Indicators for Strategic Urban Forest Planning and Management

This paper discusses some limitations to focusing primarily on canopy cover goals, and builds on the work of Clark et al (1997) to describe a more comprehensive set of criteria and performance indicators by which to measure urban forest management success.

[2] Clark, J. R., N. P. Matheny, G. Cross & V. Wake. 1997. A Model of Urban Forest Sustainability. *Journal of Arboriculture*, 23(1)17-30.

[3] Kenney, W. Andy, van Wasseanaer, Philip J.E., & Satel, Alexander L. 2011. Criteria and Indicators for Strategic Urban Forest Planning and Management. *Arboriculture & Urban Forestry*. 37(3):108-117

Community approach

The responsibility for sustaining the urban forest ultimately involves individual and neighborhood actions as well as governmental actions. Because the majority of trees exist on private land, community engagement and cooperation is vital to achieving the Plan's vision. The foundation for a successful plan is dependent on developing a community approach that includes the following elements:

- Establishment of community-wide understanding and valuing of trees and the urban forest as a community asset through outreach, education, and opportunities for engagement

Because the majority of trees exist on private land, community engagement and cooperation is vital to achieving the Plan's vision.

- Opportunities for volunteer actions
- Technical assistance to residents
- Common principles and objectives among City departments
- Clear communications and unified messaging from City departments
- Involvement of large private and institutional landholders
- Cooperation of those involved in the green industry including landscape contractors, arborists, commercial growers, and garden centers/nurseries
- Neighborhood participation and action
- Involvement of developers and business associations
- Cooperation and involvement of residential land owners
- Cooperation between government, businesses, and residents
- Linking efforts regionally

Ecological approach

Trees are not merely units to be accounted for, but are inherently part of a natural ecology. Even though urbanization has significantly altered natural ecosystem processes, trees in our urban environment are part of natural interactions and unique ecosystems. They provide ecological as well as social and economic functions and services. The ability of trees to thrive is not bound by property lines or only related to the actions of individuals. Their existence and well-being is dependent upon the interrelated actions of many people and institutions, as well as nature itself. Trees interact with and support multiple other elements in nature including salmon and other wildlife, soil, weather, climate, insects, and plants. Although a tree may have been planted by one person on a specific piece of property, once established the tree's value extends beyond that original "ownership." Collectively, trees are an essential element for human and ecological health through the environmental and social functions and services they provide.

Seattle's urban forest is dynamic, constantly changing due to human and natural impacts. Impacts may include those caused by weather events or by the removal or planting of trees for a variety of reasons. In order to allow for continuity of functions and services, our urban forest must preserve and expand canopy cover, maintain native vegetation, and be composed of a mix of species, sizes, and ages. Our ability to support a thriving urban forest for the long-term depends on taking into account the ecological conditions that support healthy trees.

The framework for an ecological approach needs to be based as much as possible on the underlying geography of Seattle, its watersheds, and the specific attributes of our urban landscape. The ability of specific properties and neighborhoods to sustain trees and forests varies over the city's landscape.

It is important that we identify place-based strategies that maximize the ability of trees to thrive and that also maximize public stewardship and identity. It is also important that we recognize competing land-use goals and develop approaches that can reduce land-use conflicts and increase our ability to enhance the urban forest. We must look beyond "ownership boundaries," such as individual property lines or publicly owned land especially as it relates to tree planting and replacement, and develop an approach that broadens our ability to support healthy urban trees.

Trees interact with and support multiple other elements in nature including salmon and other wildlife, soil, weather, climate, insects, and plants.

Exploring new ways to manage our trees

New ecological approaches will be explored in order to better manage our urban forest. One such new approach is to identify a series of sub-geographic areas or "eco-hoods." An eco-hood is a geographic area with distinct ecological, built environment, and community characteristics that determine its urban forest protection and restoration potential relative to other areas of the city. Further assessment is needed to determine how to distinguish one area (or eco-hood) from another and whether boundaries between areas are most logically based on topography, land use, or other factors.

City of Seattle

Resource management approach

The policy, planning, and resources brought to bear on the urban forest resource comprise the management framework. The UFSP has adapted the Clark et al's sustainability model to provide a structure based on land use that organizes our goals and strategies and how City departments manage trees. This approach is useful for organizing and monitoring our work and will inform additional approaches that we develop and utilize to implement strategies and actions.

Because of the differences between developed property, streetscapes, parklands,

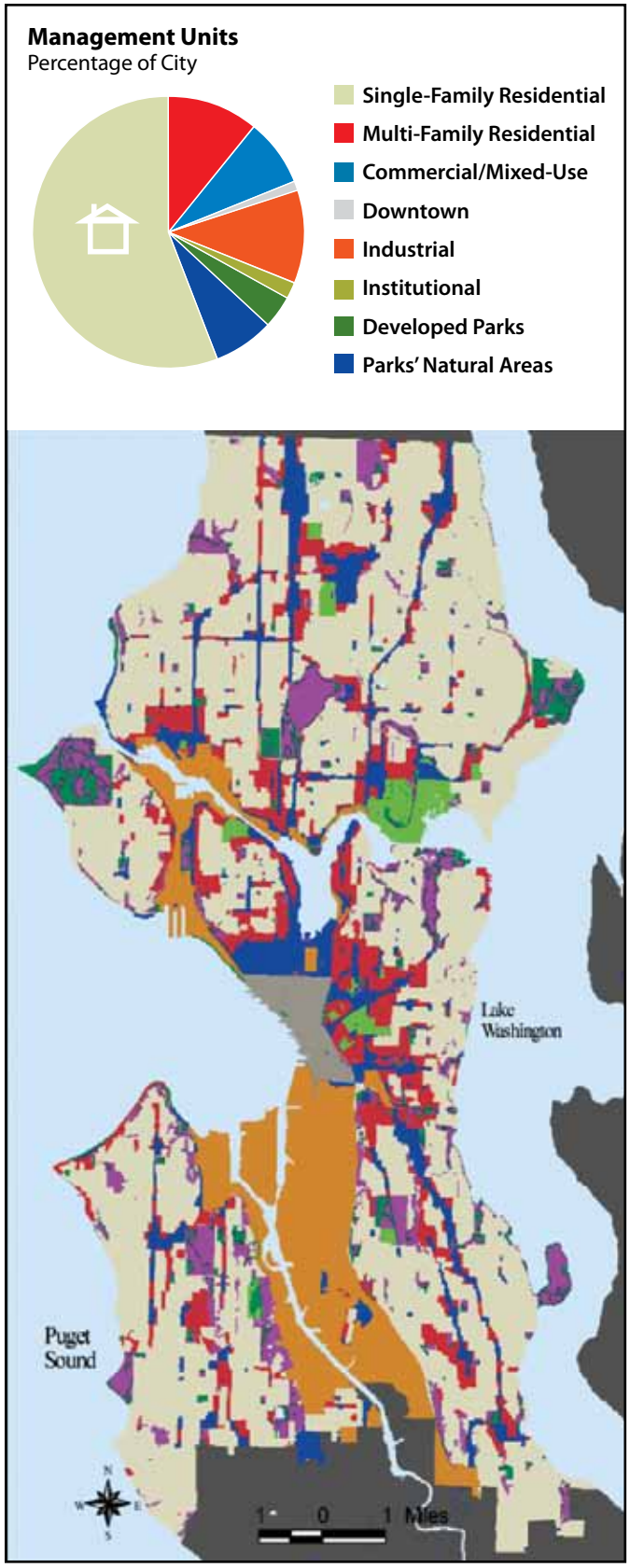
remnant forests, and other areas, the urban forest cannot be viewed as a single unit for management purposes. This plan defines nine management units that cover all the lands in the city. Using these land-use types allows for easy coordination of GIS mapping layers and for related planning initiatives. The units include eight distinct areas that were selected based upon physical characteristics. A ninth, right-of-way, goes through each of the other eight units. Figure 1 shows the geographic distribution of the management units.

The following are the nine management units for the UFSP:

1. Single-Family Residential
2. Multi-Family Residential
3. Commercial/Mixed-Use
4. Downtown
5. Industrial
6. Institutional
7. Developed Parks
8. Parks' Natural Areas
9. Right-of-Way

Figure 1. Seattle's urban forest canopy cover: distribution by management unit

*Right-of-Way is distributed throughout all of the management units and also calculated separately



Single-Family Residential

Multi-Family Residential

Commercial/Mixed-Use

Downtown

Industrial

Institutional

Developed Parks

Parks' Natural Areas

Right-of-Way

City of Seattle

The management units consider trees based on their geographic location within the city. It's also important to consider the different types trees based on ownership. For the purpose of this plan, we consider three types of trees: public, private, and street trees.

Public trees are those whose ownership and management falls exclusively to City government, such as trees in developed parks and natural areas, and landscaping on City property.

Private trees are those found on private property. However, the City plays an important regulatory and supporting role for these trees. Private trees are located in the Single-Family and Multi-Family Residential, Commercial/

Mixed Use, Downtown, Industrial, and Institutional management units.

Street trees are those found in the public right-of-way and are managed cooperatively between the Seattle Department of Transportation (SDOT) and adjacent property owners.

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Organization of the Plan

The 2013 Urban Forest Stewardship Plan is organized into the following sections:

- **The importance of Seattle's urban forest:** In this section we will talk about the history of our urban forest, our city's tradition of trees, and the functions and benefits of healthy urban forests.
- **Seattle's urban forest today:** This chapter talks about urban forest assessments and results; provides specific information on the state of our public and street trees, and talks about the challenges we are facing.
- **Current stewardship and management efforts:** This section talks about different City departments' roles and responsibilities, effort coordination, existing programs and policies, and specifics on the management of public, street trees, and trees on private property.

- **A path forward:** In this section we present the goals, priorities, and strategies we have in place to accomplish the Plan's goals, the action agenda, monitoring and indicators, and funding.
- **Future research needs:** We have identified areas in which the City would benefit from additional knowledge and information. This section talks about specific research areas that are beyond the ability of the City to develop at this point in time.

Update Process

The UFSP update was produced by the City of Seattle Urban Forest Interdepartmental Team (IDT), a working group representing City departments with tree management or regulatory responsibilities. Since the creation of the original 2007 UFMP, these departments have collaborated to assess current conditions, establish goals, and chart a path to long-term management and stewardship of Seattle's urban forest. The IDT worked closely with the Urban Forestry Commission and City Council and received valuable input and feedback for the 2013 update of the Plan. The updated plan provides a framework for the actions that will help us preserve, maintain, and enhance the condition of Seattle's urban forest.

The draft updated plan was presented to the public in an open house and six meetings with various community groups. The draft was available to the public on the City's website. More than 10 written comments were received. City Council, Council Central Staff, and the Urban Forestry Commission provided extensive input.

Key Accomplishments Since 2007

Using the 2007 Urban Forest Management Plan as the guiding document for action, Seattle has taken important steps toward the protection and enhancement of its urban forest, including:

- Creating the Urban Forestry Commission to advise the Mayor and City Council concerning the establishment of policy and regulations governing the protection, management, and conservation of trees and vegetation in Seattle (Mayor/City Council - 2009)
- Reinforcing the importance of a consistent approach to outreach and engagement around urban forestry by creating a new, permanent position to manage the reLeaf program (Mayor/City Council - 2011)
- Completing the street tree online map and updating the street tree ordinance and manual (Seattle Department of Transportation – 2012/2013)
- Enrolling 1,000 acres of forested parklands in the restoration process to remove invasive species and plant native trees and understory plants (Parks and Recreation Department through the Green Seattle Partnership - 2012)
- Implementing Green Factor and working on updating tree regulations for private property (Department of Planning and Development - 2009 and 2013)
- Producing the Green Cities Research Alliance report on Seattle's Forest Ecosystem Values, an analysis of the structure, function, and economic benefits of Seattle's urban forest (2012)
- Being named by American Forests as one of the top ten best cities in the country for urban forestry (2012)

2 THE IMPORTANCE OF SEATTLE'S URBAN FOREST

CHAPTER 2

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27 Seattle's Tradition of Trees

29 Functions and Benefits of Healthy Urban Forests

It would be hard to imagine Seattle without trees. The urban forest is an essential element of Seattle's identity as a livable and beautiful city. In 1982, a contest established the City's official nickname as "The Emerald City", in a nod to the lush evergreen forests of the area. These evergreen forests originally blanketed the hills that are now part of Seattle. The sea, rivers, forests, lakes, and fields surrounding Seattle were rich enough to support native tribes for at least four thousand years. Historically, the area that is now Seattle was dominated by lowland coniferous forests, large salt marsh estuaries, and pockets of oak prairies.

Trees have always been an important part of our landscape and economy. The urban forest that currently includes both native and non-native trees has been impacted by human development over time. In the late 1800s most of the forested lands in the Seattle area, consisting primarily of large Douglas fir, western red cedar, and western hemlock, were milled into lumber. However, the area was not universally clear-cut. There were remnants of old trees that reseeded parts of the forest. Human hands planted additional forest. This profound alteration of the landscape had a deep impact on the urban forest and can still be seen today.

Seattle's Tradition of Trees

Seattle has a rich history linked to the urban forest.

- 1879 – The last tree along Seattle's waterfront is cut down to make way for development.
- 1884 – Denny Park is dedicated as the City's first park.
- 1903 – Improvement of parking strips and street medians along Seattle streets begins.
- 1903 – Olmsted Brothers Landscape Architecture firm is hired to develop a plan for a city-wide park and boulevard system.
- 1908 – A Comprehensive System of Parks and Parkways report is issued (the Olmsted Plan).
- 1927 – Construction of the Seattle Center campus begins.
- 1959 – Planting of street trees along Third, Fourth, and Fifth Avenues in preparation for the 1962 World's Fair begins.
- 1967 – Operation Green Triangle, approved as part of the King County Forward Thrust Bond measure, beautifies over 50 street triangles. City efforts include the Urban Tree Replacement Program (Seattle City Light), the Millennium Woods Legacy Project (Parks), and the Fall Tree Fund (Department of Neighborhoods).
- 1982 – Seattle adopts the nickname "The Emerald City."
- 1989 – The $41 million Open Space Bond Measure passes.
- 1994 – Funds from the Cumulative Reserve Fund are allocated for forested parklands restoration.
- 1994 – Seattle's first Heritage Tree is recognized by City Council.
- 1998 – Seattle Parks and Recreation acquires nearly 600 acres of open space to be maintained in a natural state in perpetuity.
- 1999/2000 – 26,000 new trees are planted throughout the city as part of the Millennium Woods Legacy Project.
- 2001 – Dutch Elm disease is discovered in Seattle. City government provides emergency funding to control of the spread of the disease.
- 2004 – The Green Seattle Partnership is formed as a collaboration between the City and non-profit Forterra (then Cascade Land Conservancy) to restore 2,500 acres of forested parklands by 2025.
- 2007 – The Urban Forest Management Plan is created with the goal to increase Seattle's tree coverage to 30 percent by 2037.
- 2009 – The Urban Forestry Commission is created to advise the City Council and the Mayor on policies and regulations governing Seattle's urban forest.

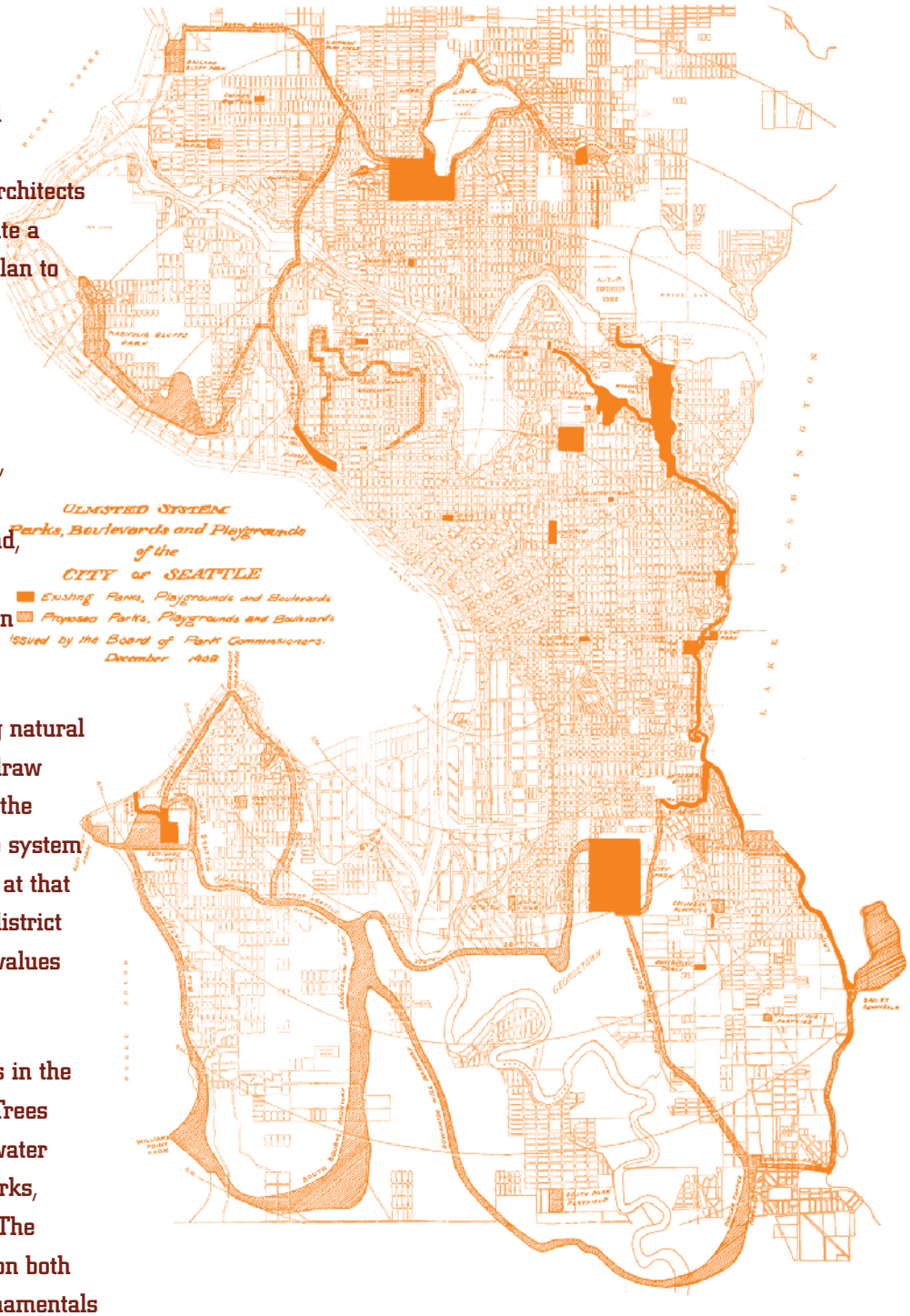
The Olmsted Legacy

In 1903, the Seattle City Council decided to develop a city-wide park system and hired the Olmsted Brothers Landscape Architects firm in Brookline, Massachusetts, to create a design. In 1908, the firm expanded the plan to include newly annexed areas to the north and south of the city. John Charles Olmsted's park and boulevard plan (see map on Figure 2) laid out a system of large parks, smaller neighborhood parks, and boulevards. These parks included Interlaken, Seward, Green Lake, Woodland, Washington, and Jefferson parks, as well as scenic drives such as Lake Washington and Magnolia Boulevards.

The plan capitalized on the city's existing natural beauty, using "borrowed landscapes" to draw distant water bodies and mountains into the view from the parks and boulevards. The system encompassed the entire city as it existed at that time, excluding the downtown business district where prior development and high land values precluded the acquisition of parklands.

Trees played a variety of significant roles in the Olmsted plan for parks and boulevards. Trees framed vistas of distant mountains and water bodies, they separated "rooms" within parks, and they formed allées along parkways. The Olmsted firm's plan placed a high value on both ornamental and native species, using ornamentals in more formal spaces, such as the center strip of Montlake Boulevard, and preserving or planting native species in naturalistic designs, such as in Seward Park.

Figure 2. 1908 Olmsted Parks Map.



The Friends of Seattle's Olmsted Parks is developing The Olmsted Trust in cooperation with Seattle Department of Parks and Recreation to establish stewardship organizations for Olmsted-designed and -influenced landscapes within the park system. This past year, the trust has helped further the impressive work being done to renovate Magnolia Boulevard and established the Volunteer Park Trust.

Functions and Benefits of Healthy Urban Forests

A healthy, well-managed urban forest provides numerous ecosystem, economic, and social functions and values for the city. The Seattle's Forest Ecosystems Values study quantified a subset of the benefits and functions Seattle's urban forest provides, specifically air pollution removal values, carbon sequestration and storage, energy savings, and replacement value. For example:

- An estimated two million metric tons of carbon dioxide equivalent is stored in Seattle's trees and tree-like shrubs, with an additional 140,000 metric tons of carbon dioxide equivalent sequestered by trees and tree-like shrubs annually. These carbon benefits are estimated to equal $10.9 million in savings from carbon storage and $768,000 annually from carbon sequestration.
- The forest in Seattle removes 725 metric tons of pollution from the environment every year, providing a pollution-removal value of $5.6 million annually.
- Seattle's urban forest reduces energy use in residential buildings by roughly 166,000 million British thermal units of natural gas and 43,000-megawatt hours of electricity, for an annual savings of $5.9 million by the City and residents.[4]

Additional benefits and functions are documented in numerous studies and reports. These include:

Storm water reduction

Trees intercept rain water and prevent a portion of it from reaching the ground; fallen leaves help build the soil up, which in turn retains moisture, slows and cleans runoff, and recharges the groundwater; tree roots absorb water that eventually is released into the atmosphere by transpiration.[5]

By reducing runoff and capturing pollutants, trees also help protect water quality in Puget Sound, Lake Washington, Lake Union, and urban creeks.

Pollution removal

Trees and other plants improve air quality by intercepting particulate matter and absorbing pollutants. Analysis of research plot data done in the Seattle's Forest Ecosystem Values study[6] found that Seattle's urban forest removes approximately 725 metric tons of pollutants every year (Figure 3). This service is valued at $5.62 million (Figure 4).

[4] Green Cities Research Alliance, August 2012. Seattle's Forest Ecosystem Values. Analysis of the Structure, Function, and Economic Benefits.

[5] Fazio, Dr. James R. "How Trees Can Retain Stormwater Runoff." Tree City USA Bulletin 55. Arbor Day Foundation.

[6] Green Cities Research Alliance, August 2012. Seattle's Forest Ecosystem Values. Analysis of the Structure, Function, and Economic Benefits.

Figure 3 – Annual pollution removal

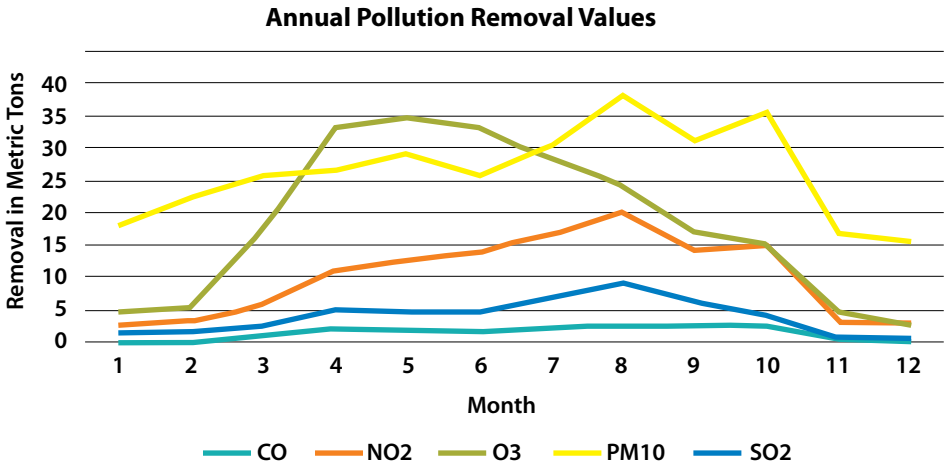
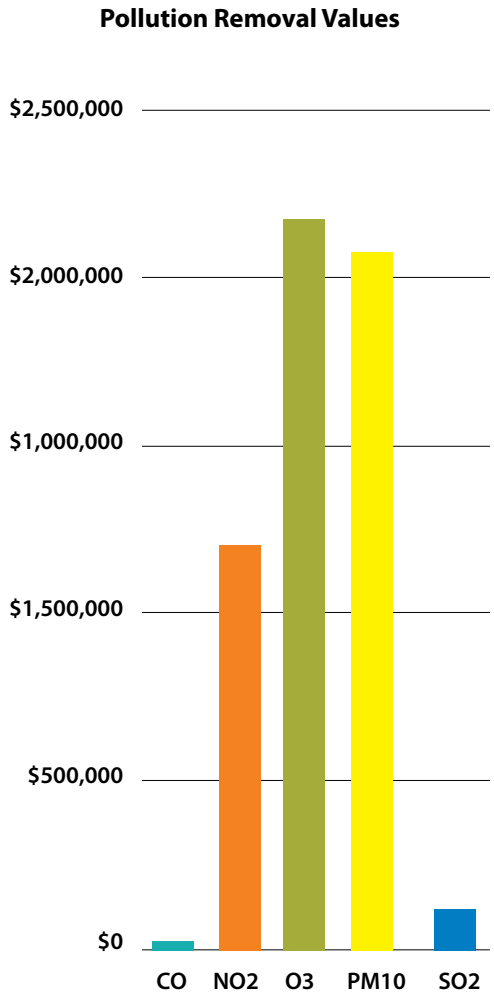


Figure 4 – Pollution removal values



Carbon storage and sequestration

Carbon dioxide (CO2) is the greenhouse gas that is most commonly associated with climate change. Trees help reduce concentration of CO2 by sequestering and storing carbon. The Seattle i-Tree study showed that in 2011, urban forests in Seattle stored over two million metric tons of CO2-equivalent and sequestered 141,000 metric tons of CO2-equivalent (see Figure 5). These services are valued at $10.9 million from one-time carbon storage benefits and $768,000 in annual benefits from carbon sequestration.

Mature large trees store the most carbon in Seattle's urban forest. Carbon sequestration also varies based on tree species and ages. The management units with the largest tree species sequester most of the carbon. In Seattle, Parks' Natural Areas and Developed Parks are the management units that store and sequester the most carbon. (See Figure 6) [7]

Carbon storage
is the carbon contained in plant roots, stems, and branches

Carbon sequestration
is the removal of CO2 from the atmosphere by plants through photosynthesis

Figure 5 – Carbon storage by management unit

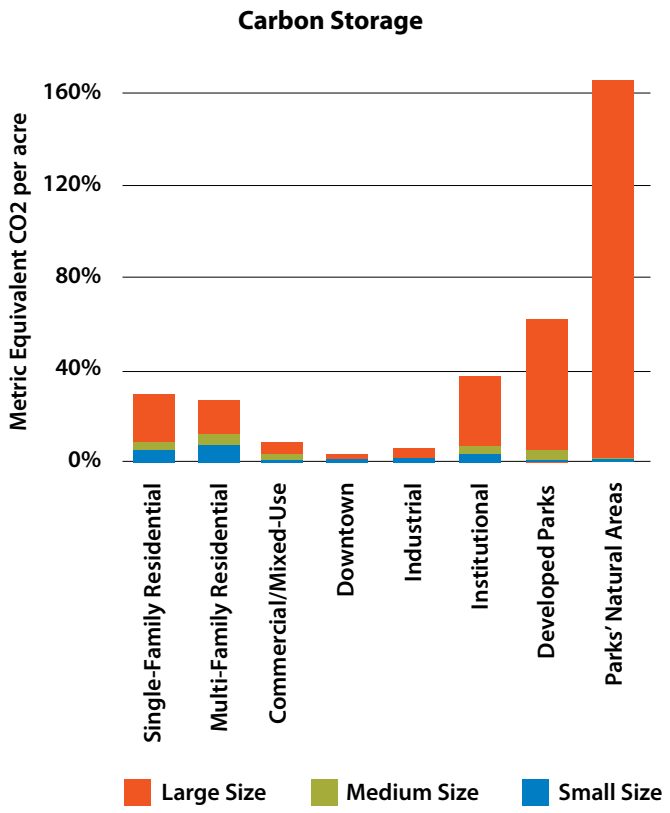
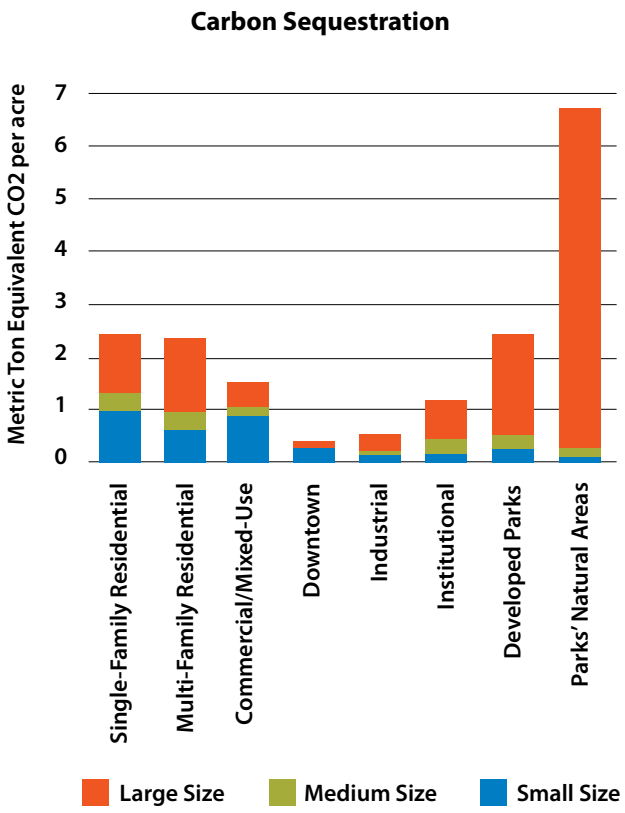


Figure 6 – Carbon sequestration by management unit



[7] Green Cities Research Alliance, August 2012. Seattle's Forest Ecosystem Values. Analysis of the Structure, Function, and Economic Benefits.

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Terrestrial and aquatic habitats

Seattle's urban forest is home to diverse wildlife, and provides the food, shelter, and nesting opportunities that are essential to supporting it. Trees provide shade that cools streams and they intercept rainwater and lessen the impacts from storm events. Trees also reduce fluctuations in stream flows, improving water quality. Trees play a vital role in protecting salmon in streams by providing shade, organic input, and a buffer from human interference. They also play an essential role as habitat for nesting birds. Certain bird species, specifically herons and eagles, have unique nesting requirements that make it especially important to identify and preserve trees that provide urban nesting sites where possible.

Trees play a vital role in protecting salmon in streams by providing shade, organic input, and a buffer from human interference.

Steep slope stability

Steep slopes include areas located outside of the downtown and high-rise zones with an incline of 40 percent or more. Steep slopes present an environmental risk from erosion that can impact downhill creeks and drainage basins, as well as threaten life and property. The root systems of trees and vegetation help stabilize steep slopes. The Environmentally Critical Area code provides specific standards for development and tree and vegetation retention in these areas.

Residential building effects

When the urban forest moderates local climate, it translates to reduced energy costs for residents. Depending on the species, size, and proximity to a house, trees have different impacts on residential heating and cooling needs. Urban trees affect temperatures by blocking wind, shading buildings and roads, and by cooling surfaces through water evaporation.

In Seattle, an estimated 1.6 million British thermal units of natural gas and 43,000 megawatt-hours of electricity are saved every year thanks to the urban forest. This represents close to $6 million in annual savings.

Economic vitality

Recent studies from the University of Washington and other research institutions have shown that trees positively affect the economic vitality of communities by increasing property values, office occupancy rates, and shopping frequency, while lowering crime rates and health care costs.

Public health effects

Studies have identified a relationship between the natural environment and improved health outcomes. A recent study showed that loss of trees to the emerald ash borer increased mortality related to cardiovascular and lower-respiratory-tract illness.[8]

Neighborhood livability

The presence or absence of trees can define a neighborhood. Studies show that people enjoy trees and are less stressed with the presence of trees in a landscape than they are without them. There are also studies that show that people in tree-lined neighborhoods are more likely to spend time outside getting to know their neighbors and building community than those in neighborhoods without trees.[9]

Food production and urban foraging

Appropriately sited and maintained fruit and nut trees in urban environments provide a valuable food source for Seattle residents. Seattle's urban forests contain non-timber forest products such as wild foods and medicines. Research shows that Seattle's urban forests have a multifunctional role that contributes to the well-being of urban residents. Urban foraging maintains traditions and social ties while deepening connections with nature. Gathering offers positive physical and mental health benefits as well allowing those involved to be part of a larger set of processes related to food and health sovereignty and justice.[10]

The presence or absence of trees can define a neighborhood. Studies show that people enjoy trees and are less stressed with the presence of trees in a landscape than they are without them.

[8] Donovan, Geoffrey H., et al. The Relationship between Trees and Human Health. Evidence from the Spread of the Emerald Ash Borer." *American Journal of Preventive Medicine.* 2013; 44(2):139-145.

[9] Kuo, F.E., Sullivan, W.C., Coley, R.L., & Brunson, L. (1998). Fertile ground for community: Inner-city neighborhood common spaces. *American Journal of Community Psychology*, 26(6), 823-851.

[10] Poe, Melissa R., Rebecca J. McLain, Marla Emergy, and Patrick T. Hurley. Urban Forest Justice and the Rights to Wild Foods, Medicines, and Materials in the City. Human Ecology. 2013.

3 SEATTLE'S URBAN FOREST TODAY

CHAPTER 3

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43 Additional Information on the Condition of Public and Street Trees

47 Challenges to the Urban Forest Resource

Seattle has between 1.6 and 3 million trees and a diversity of understory plants occurring within a diverse range of environments, from natural areas with multi-story plants to downtown areas with individual trees planted in small tree pits. Overall, the urban forest of Seattle is a highly managed environment that has been profoundly shaped by its past and current residents.

Infrastructure systems are essential for supporting human activities and well-being in urban environments. The urban forest is part of our green infrastructure system, which works in concert with grey infrastructure, such as drains, pipes, and wires, to deliver important services. It is estimated that the replacement value of Seattle's existing urban forest (the cost to re-plant trees and nurture them to their current size) is close to $5 billion.

Understanding the state of the urban forest is a critical step in active management. To this end, the City of Seattle is committed to undertaking periodic city-wide canopy assessments and more detailed analysis as practical, including:

- **City-wide canopy assessment:** Assessment of canopy cover by remote aerial sensing, such as satellite or LIDAR imaging, provides a low-cost method of surveying canopy quantity.

E. F. Blaine, Captain Pratt, E. F. Fuller, John C. Olmsted, P. R. Jones, C. W. Saunders, J. E. Shrewsbury, A. L. Walters. City of Seattle Archive 1903 #3100.

- **Sampling surveys:** Detailed analysis of selected sites can be extrapolated to provide data on the overall quality of a larger area.
- **Inventories of strategic assets:** Tree-by-tree measurement and geo-location provide a detailed assessment of quantity and quality.

Below is a summary of key efforts the City has undertaken.

Assessment Methods

The City has used a variety of urban forest assessment methods in order to have a better understanding of the urban forest resource.

Canopy cover

To create a baseline to monitor progress toward the canopy cover goal, the City commissioned a canopy cover assessment in 2009. The process used 2-foot-by-2-foot resolution Quickbird multi-spectral satellite imaging and was undertaken for two sets of data, one from 2002/3 and the other from 2007. While a specific margin of error was not provided, it is important to note that canopy cover assessments have typical error ranges up to +/- five percentile points.

City of Seattle

The City has commissioned canopy cover assessments in the past. One in 1998 used 40-foot-by-40-foot LandSat data and another in 2001 used LIDAR data; however, these efforts used low-accuracy techniques and are thus not discussed in this plan.

Using information gathered during the 2007 canopy cover assessment, the City developed planting potential data in an attempt to better inform existing canopy cover goals. The analysis identified areas of pervious surface that did not have tree canopy cover and used an algorithm to determine the number of trees that could fit in these spaces using simulated 10-foot, 15-foot, and 25-foot canopy diameter trees.

This analysis resulted in planting potential measured both in number of trees and canopy area at maturity. Because this analysis includes areas which may be inappropriate for trees, such as playfields and gardens; areas with limitations due to utilities; or areas where property owners may desire other uses, further analysis and ground truthing is necessary for this data to be useful in analyzing current goals.

Seattle's Forest Ecosystem Values study (i-Tree survey)

The Green Cities Research Alliance, a collaboration between the USDA Forest Service Pacific Northwest Research Station, University of Washington, King County, Forterra, and the City of Seattle, conducted a sampling survey of Seattle's trees using the program i-Tree Eco (previously known as the UFORE model). i-Tree is a peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis-and-benefits assessment tools.

Data collection began in Seattle in the summer of 2010 and was completed in the summer of 2011. Data was collected from 223 randomly selected plots across Seattle's forest management units, as defined by the UFMP. This survey produced data on evergreen versus deciduous breakdown, size, and condition information that have been incorporated into this UFSP update. Further analysis of information regarding species diversity, density, leaf area and biomass, pest susceptibility, and species origin and invasiveness is required.

Parks' vegetation and forest management plans

The Department of Parks and Recreation (Parks) has not had the resources to develop a complete inventory of the estimated 100,000 trees in developed parks, but it has completed over 120 vegetation or forest management plans for individual parks over the last 15 years. These plans include assessments of existing conditions including the health of the urban forest. Information on individual parks is available on Parks' website.[12] Parks estimates it has over 500,000 trees in the 2,500 acres of Parks' Natural Areas. Through the Green Seattle Partnership, Parks is building a database on species composition and tree numbers within these areas. To date, 500 acres have been inventoried.

[11] i-Tree Eco – www.itreetools.org/eco/index.php

[12] www.seattle.gov/parks/horticulture/vmp.htm

Street tree inventory

The Department of Transportation (SDOT) conducted an inventory of street trees in 1992 for all areas of the city with curbs and gutters. While this inventory has not been comprehensively updated, SDOT has continued to add trees that have been planted through SDOT Capital Improvement Projects, the Bridging the Gap levy, Seattle City Light's (SCL) Urban Tree Replacement Program, Seattle reLeaf's Trees for Neighborhoods program, and permits received by the City. Today, around 140,000 trees are included in the inventory including the approximately 40,000 City-maintained street trees.

In 2012, SDOT made individual tree information available to the public via their web-based street tree map [13] (Figure 7). Users can click on an individual tree to obtain the common and scientific name, the inventory identification number, the tree diameter, the street address, the party responsible for maintenance, the date the tree was planted or inventoried, and the date the tree was last checked.

Figure 7. SDOT's street tree online map

Evergreen conifer tree.

Evergreen broad leaf tree.

Deciduous tree.

[13] Seattle Department of Transportation. Seattle Street Trees. Web http://web1.seattle.gov/SDOT/StreetTrees

Assessment Results

Below are the results from the different assessment methods used to better understand the urban forest resource.

Canopy cover

Analysis of 2007 QuickBird satellite data found that Seattle has about 23-percent canopy cover or approximately 12,500 acres of canopy. Canopy cover was also determined by management unit as shown in Table 1.

Table 1. Existing canopy cover by management unit

Management unit	Land area (acres)	% of city land area	Estimated 2007 canopy cover
Single-Family Residential	30,452	56%	26%
Multi-Family Residential	5,982	11%	17%
Commercial/Mixed Use	4,350	8%	10%
Downtown	544	1%	9%*
Industrial	5,982	11%	4%
Institutional	1,088	2%	19%
Developed Parks	2,175	4%	25%
Parks' Natural Areas	3,807	7%	80%
City-wide	54,379		23%
Right-of-Way	14,682	27%	18%

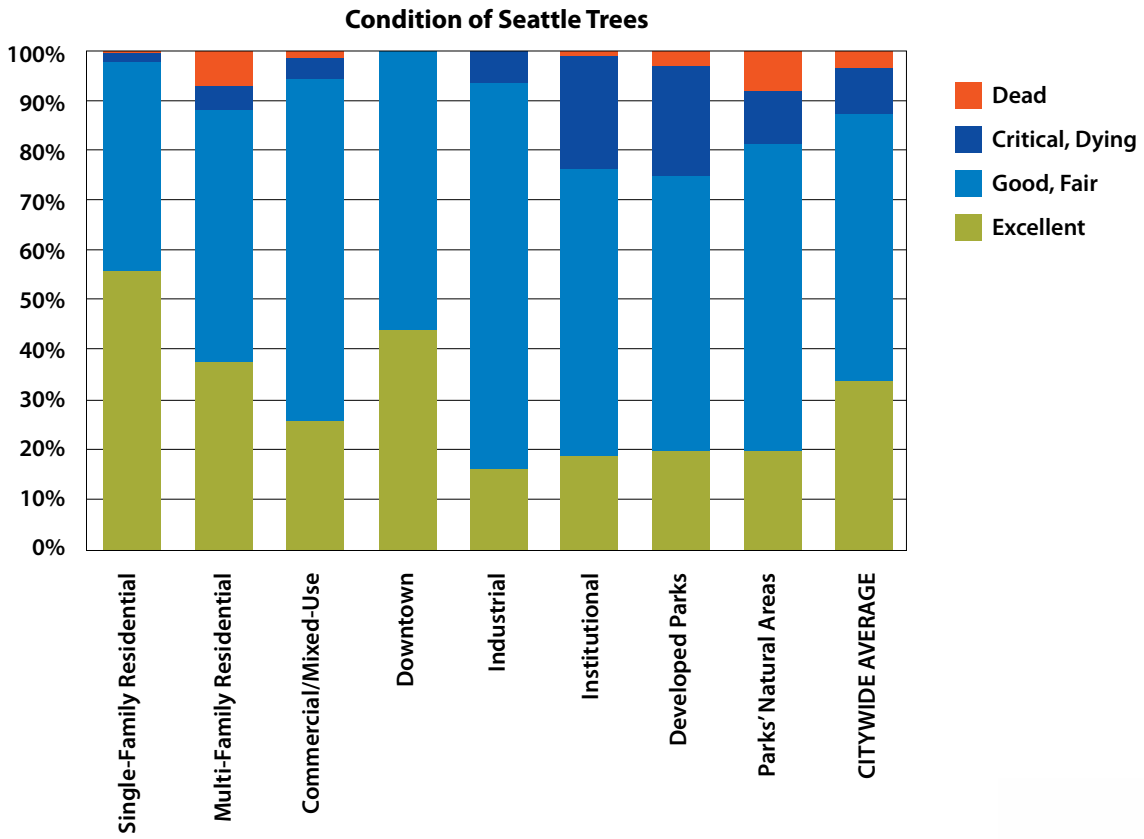
*Shading caused by downtown tall buildings was the reason why canopy cover for this management unit was under-represented. SDOT analysis of their existing tree inventory confirmed that downtown's canopy cover is closer to 9 percent.

While canopy cover is a critical measure of overall health of the urban forest, it is difficult to establish guidelines for what canopy cover should be. While it is obvious that canopy cover is substantially less than it was prior to European settlement and substantially more than it was after the timber harvests of the late 1800s, a more detailed comparison to historical conditions is not reliable because good canopy analysis technologies have only been developed in recent years. Comparison to other cities is also very difficult due to the unique conditions of each location (geographic size, level of density, amount of parks land, amount of roadway, amount of environmentally critical areas, industry composition, climate, etc.).

Health and longevity

The iTree survey generated basic data on the health of trees as well as the average diameter of trees. This data is summarized in Figure 8 below. While this data provides an important snapshot of the urban forest, it is difficult to draw conclusions about this data without long-term information to understand trends or comparative data for similar cities. Overall, this information suggests that Seattle's trees are within generally acceptable ranges for tree health.

Figure 8: Condition of trees by management unit



Age and species diversity

The iTree survey provided two measurements that help to quantify the species and age diversity of the urban forest. One is the percentage of evergreen and deciduous trees and the other is an average diameter of the trees. Native Pacific Northwest forests tend to be predominately evergreen conifers (e.g., cedars, pine, spruce, hemlock, fir) with a smaller mix of deciduous trees (e.g., maple, cottonwood, alder) focused in disturbed areas or on steep slopes. Broadleaf evergreens are almost entirely exotics (e.g., holly, magnolia) with the exception of the native Pacific madrone (madrona), which generally grows on dry, gravelly soils or on steep slopes in limited areas.

Evergreen trees tend to provide greater environmental benefits because they maintain their canopy year-round, including during the rainy season, slowing and reducing storm water run-off and absorbing more carbon dioxide and air pollutants. However, evergreen trees are longer-lived and tend to have much greater size potential, so residents are often hesitant to plant them and they are only allowed as street trees in limited situations. City-wide, 31 percent of trees are evergreens (22 percent conifers and 9 percent broadleaf) and 69 percent are deciduous trees, although this ratio varies substantially between different land use types (Table 2).

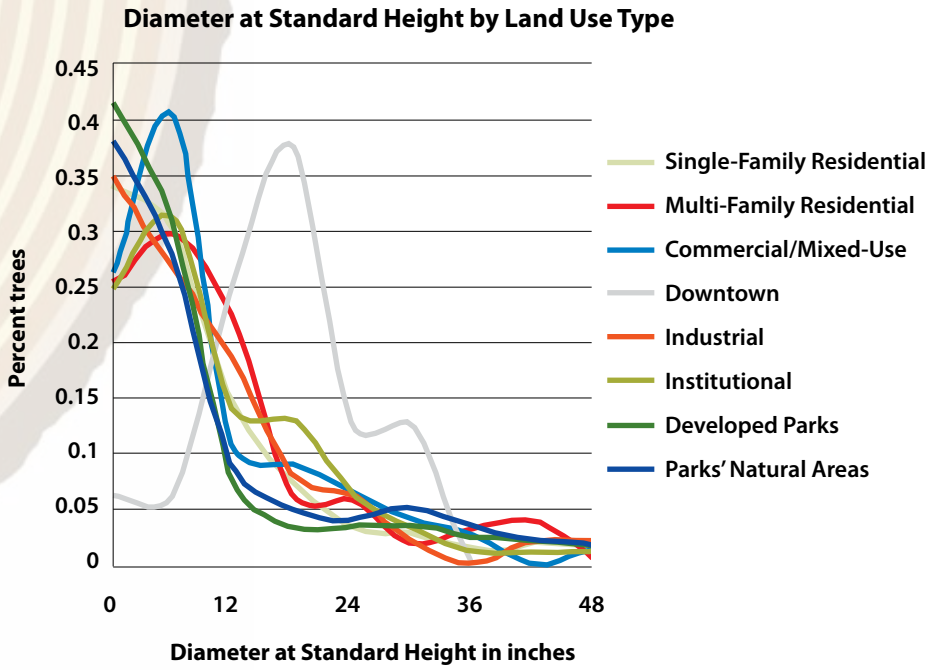
City of Seattle

Table 2: Evergreen/deciduous breakdown

Land use	Evergreen		Deciduous
	Broadleaf	Conifer	
Single-Family Residential	15%	34%	51%
Multi-Family Residential	9%	9%	82%
Commercial/Mixed Use	0%	40%	60%
Downtown	0%	0%	100%
Industrial	0%	32%	68%
Institutional	0%	16%	84%
Developed Parks	8%	20%	71%
Parks' Natural Areas	8%	10%	82%
City-Wide	9%	22%	69%

City-wide, about 34 percent of trees are 6 inches in diameter-at-standard-height (DSH) or smaller and 64 percent of trees are 12 inches in diameter or smaller. The prevalence of smaller-sized trees suggests that most trees are well below their growth potential; however, without additional data it is not possible to distinguish the cause of this pattern, which could be due to the predominance of small species trees, frequent removal, or even to an increase in the planting of new trees.

Figure 9: Diameter of trees by management unit



Invasive species

Invasive species are those species that are not originally native to an area and which can out-compete other vegetation to the detriment of the overall ecosystem. In Seattle, English laurel, English holly, Himalayan blackberry, English ivy, and morning glory represent some of the most prevalent and problematic invasive species. The iTree survey calculated the percentage of the total trees that are represented by English laurel and English holly (see Table 3).

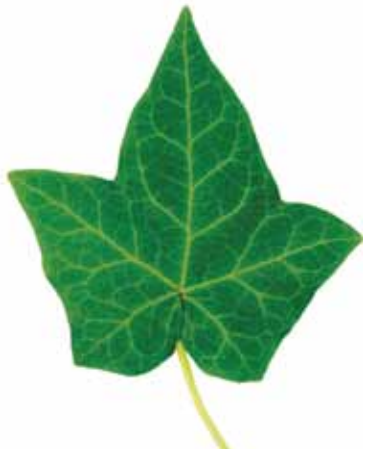


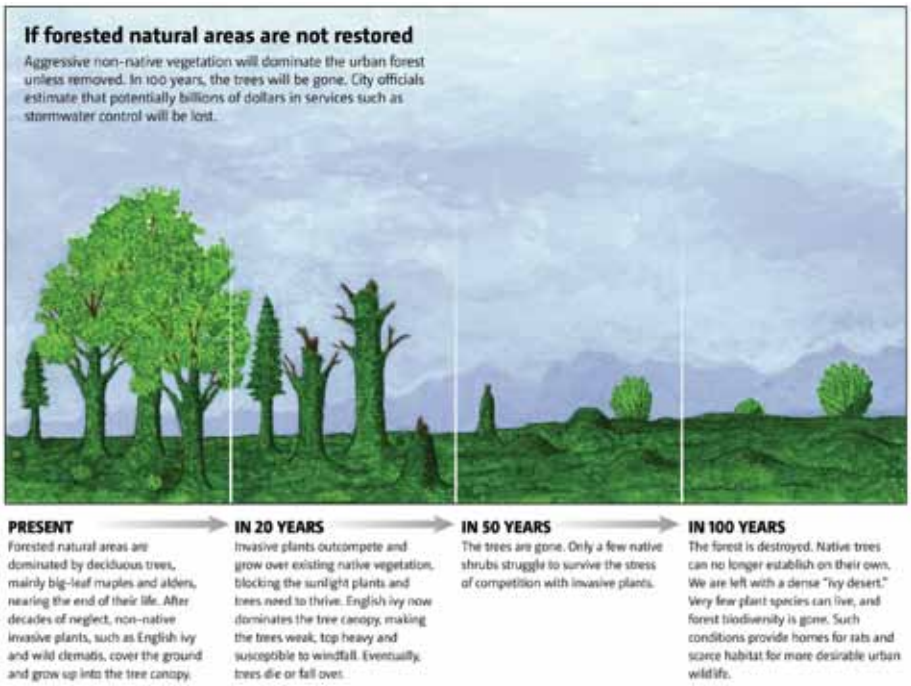
Table 3: Percentage of trees that are English laurel or English holly

Land use	English laurel	English holly
Single-Family Residential	4%	3%
Multi-Family Residential	1%	2%
Commercial/Mixed Use	0%	0%
Downtown	0%	0%
Industrial	0%	0%
Institutional	0%	0%
Developed Parks	0%	1%
Parks' Natural Areas	5%	3%

In Seattle, English laurel, English holly, Himalayan blackberry, English ivy, and morning glory represent some of the most prevalent and problematic invasive species.

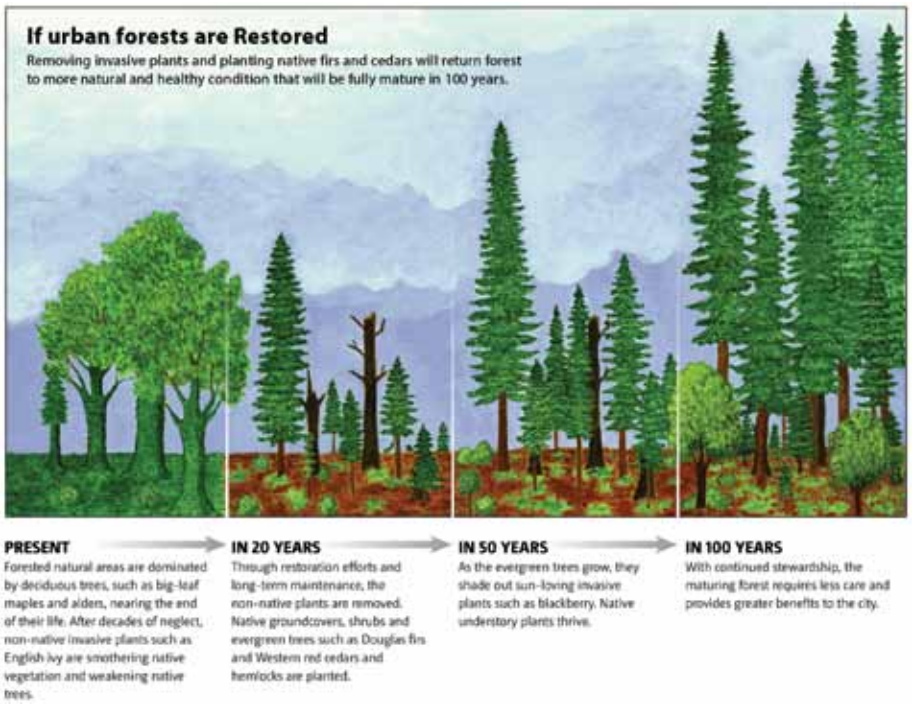
City of Seattle

Figure 10 – Seattle natural areas not restored



If our forested parklands are not restored and invasive species removed, aggressive non-native vegetation will dominate the urban forest. In one hundred years, our native trees will be gone. Potentially billions of dollars in services will be lost (figure 10).

Figure 11 - Seattle natural areas after restoration



If forested parklands are restored by removing invasive vegetation and planting native trees and shrubs, the urban forest will return to a more sustainable condition. In one hundred years, the forest will provide the city valuable services and will better resist invasive plant infestations (Figure 11).

Additional Information on the Condition of Public and Street Trees

The City has direct responsibility for the management of public and street trees. Parks and SDOT have programs dedicated to the maintenance of trees in developed parks, in forested parklands, and in the right-of-way.

Trees in developed parks

Developed parks represent only 4 percent of the city's land base, but include

some of the largest specimens in the city. These trees play an important role in the urban forest as they experience a high volume of use from individuals looking to enjoy the city's natural beauty. While a great deal of work has gone into assessments of the urban forest in individual parks, there is little data on the City's developed park system as a whole. Below are three key issues that are currently being faced by developed parks.

Hazard mitigation: Although it is very comparable to major institutions--a land use with similar characteristics--developed parks have a large number of trees in critical or dying condition. This indicator is not surprising given the presence of many trees that are reaching the end of their lives, an abundance of tree species, such as big leaf maple and cottonwoods that are prone to hazard conditions, and limited maintenance budgets. However, it is also a concern as hazard tree mitigation is a high priority within this area due to high levels of use. Due in part to this prioritization, tree removal makes up one-third of the current crews' workload, which reduces the budget for other work, including preventive maintenance that could reduce future hazard mitigation workload.

Hazard tree removal makes up one-third of the current crews' workload, which reduces the budget for other work.

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Tree replanting: Currently, Parks has an underfunded two-for-one tree replacement program. Each removed tree is scheduled for replacement with two trees, however funding for the program has not kept up with the demand for replanting. New capital projects and major maintenance-funded landscape restoration projects typically do include tree replacement. A modest number of trees are planted each year within the Parks general fund programs. New tree planting should focus first on replacement trees so that the original architecture/design of a park can be restored.

Wood and green-waste recycling: It is currently estimated that City parks produce the equivalent of over 2,500 cubic yards of chipped wood

mulch annually, which is used by the landscape and forest restoration program. Research in forest restoration has found that the amount of wood debris is the best indicator of forest health. Valued woods, such as oak, elm, cedar, and walnut are sold for recycling. A large amount of "clean-green" waste is produced through maintenance operations and hauled to private vendors for composting. In turn, the City often buys back the composted material for use in landscapes. While most wood and green waste products are recycled, it is costly to do so. Reviews of use patterns of wood waste have found that current methods of use are as efficient as the current system will allow. In 2011, a wood recycler offered to handle all wood wastes for Parks in exchange for the valued wood. However, the recycler found that the volume of materials would not provide benefit to either party and so the arrangement was terminated. The City has found the best use for most woody biomass is its use as mulch and compost for forest health improvement.

Trees in park department's natural areas

Trees in natural areas represents 7 percent of the city's land base, including publicly owned forests, riparian corridors, meadows, wetlands, and portions of parks that are in a natural state--with some true remnant forest. Ecosystem complexity and value varies greatly within these areas, most of the area consisting of steep hillsides and watershed ravines. The majority of Seattle's salmon-bearing streams are within these areas, including about eight miles of urban creeks within 800-plus acres of watersheds.

The current canopy coverage in natural areas is 80 percent. A very low percentage of trees (18 percent) in these natural areas are evergreen (8 percent broadleaf and 10 percent conifers) and too many (82 percent) are deciduous. Most of the trees are second-growth deciduous forests that are past their prime and are in serious decline. The presence of highly invasive species is a further threat to trees and understory. Forest restoration projects, such as the Green Seattle Partnership, are working to combat this situation. Thousands of seedlings are planted during restoration activities each year with support from thousands of volunteer residents.

Trees in the right-of-way (street trees)

Trees in the right-of-way (street trees) are managed by SDOT and represent 27 percent of the city's land base. Of the more than 140,000 trees along Seattle's right-of-ways, SDOT maintains about 40,000. The remaining 100,000 are the maintenance responsibility of the abutting property owners and regulated by the City through permits issued by SDOT for tree removals and new plantings within street-side planting strips.

There are right-of-way areas that remain unopened due to location on steep slopes or in parks. SDOT has created a GIS layer for unimproved right-of-way areas and is exploring maintenance opportunities through the Green Seattle Partnership. SDOT is currently inventorying shoreline street ends and is considering using annual encroachment permit fees as a possible way of funding maintenance of these areas.

The current canopy coverage for trees in the right-of-way is 18 percent. Because the i-Tree survey did not gather right-of-way specific data, existing condition information is based on inventory data from 1992 and visual observations. Size distribution of street trees in residential areas has not changed much in the last 10 years. Nearly 50 percent of residential street trees have diameters of 5 inches or less and are relatively young. Many others are larger, with diameters of 6 to 20 inches, yet are young enough to provide benefits for many more years.

Diversity: Seattle's current street tree inventory includes 105 different genera (subfamilies) and more than 310 species. Diversity, however, is a problem because 67 percent of the street tree population is made up of just seven genera with Prunus (cherries, plums, and laurel) being the most widely planted at 24 percent, with Acer (maples) ranking second at 18 percent. Together, Prunus and Acer comprise 42 percent of Seattle's street trees, a number that goes against the general recommendation that no more than 10 percent of any one genus predominate the urban forest. Planting levels greater than 10 percent in any one species should be discouraged.

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Size distribution: Seattle's street trees have a broad range of size classes (a proxy for age) although the number of 20-inch-diameter (large) trees has decreased. More trees are being planted than lost, precluding any sudden barrenness as trees reach the end of their lifespan. In residential areas, the size distribution of street trees has been virtually unchanged for a decade. Nearly half of these trees are relatively young and have diameters of 5 inches or less (Table 4). Many others are larger, with diameters of 6 to 20 inches, yet are young enough to provide benefits and services for many more years. In residential areas, off-street trees are on average generally larger than on-street trees, but no data have been collected on their sizes.

More trees are being planted than lost, precluding any sudden barrenness as trees reach the end of their lifespan. In residential areas, the size distribution of street trees has been virtually unchanged for a decade.

Table 4. Diameter classes of Seattle's residential street trees

Diameter	0 - 5"	6 - 12"	13 – 20"	21 – 30"	>30"
Original inventory	38,232 (47.2%)	29,808 (36.8%)	8,424 (10.4%)	3,240 (4.0%)	1,296 (1.6%)
Current sampling	63,008 (48.9%)	48,190 (37.4%)	13,400 (10.4%)	2,577 (2.0%)	1,675 (1.3%)

SDOT estimates that about 20 percent of street trees could be considered as candidates for removal due to improper location (e.g., large trees under utility lines, conflict with underground utilities, sidewalks, insufficient growing space) or structural and health issues. SDOT currently removes trees only if they pose an imminent hazard or if removal allows the City to take advantage of opportunities to remove or replace trees as part of a larger planting project. SDOT also frequently removes privately maintained unhealthy trees when they become imminent hazards.

Challenges to the Urban Forest Resource

While most Seattle residents greatly value and enjoy trees, attitudes toward trees can vary from deep connection to perceiving trees as a burden. The presence of trees in an urban environment must be balanced with city-wide goals such as property rights, growth management, transportation, economic development, and urban design, as well as the goals of property owners such as access to sunlight, views, aesthetics, or competing uses such as vegetable gardens or play areas. Within the right-of-way, trees must be planted to accommodate sidewalks, utilities, and other infrastructure. The requirements

of maintenance to remove leaves, deal with fruit, and pay for pruning or damage caused by dropped branches can also become a substantial issue. Below are the major challenges that were considered in development of an urban forest action agenda.

Lack of knowledge about proper tree care

Improper maintenance impairs tree health and shortens tree lifespan. Being the owner of healthy trees requires an investment in proper maintenance. Education is an ongoing process, but even for people who know how to correctly prune, it is difficult and sometimes costly to prune mature trees that require climbing, large equipment, and specialized skills. These challenges have lead to relatively poor tree maintenance practices on private property overall. Basic education about the needs of urban trees and proper methods for pruning and maintenance could produce substantial improvements over the long term.

Education is an ongoing process, but even for people who know how to correctly prune, it is difficult and sometimes costly to prune mature trees that require climbing, large equipment, and specialized skills.

Invasive species

Over the years, many foreign tree, shrub, and ground-cover plant species have been introduced to the Seattle region only to become invasive,

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threatening the native species. Trees such as English holly, English laurel, tree of heaven, and others now flourish in our forests in place of more desirable native species. Likewise, shrubs and ground covers such as English ivy, Himalayan blackberry, and Japanese knotweed threaten our forest floors and riparian corridors. These species prevent natural recruitment of new trees in natural areas and contribute to the poor health of forested and other natural areas in the city.

Pests

While there is a rich diversity in Seattle's urban forest, the i-Tree survey suggests that four major pests can potentially damage our urban forest: Asian long-horned beetle, gypsy moth, emerald ash borer, and Dutch elm disease. The report calculated that risks posed by these pests and diseases could have an impact on Seattle's urban forest of close to $3.5 billion dollars.

Soils and available growing space

Soils conditions affect tree growth and development and are influenced by activities that occur in urban environments. Soils are living systems that require a balance of adequate aeration and moisture retention to support the presence of organic material and microbial activity and provide adequate space for healthy root systems. It is important to avoid the problems with soil compaction, reduced soil aeration, and erosion often associated with construction in order to protect existing trees and provide appropriate soil conditions to encourage tree growth and development. In order for trees to thrive, they need sufficient soil volume and sufficient growing space. Providing sufficient volume is sometimes difficult due to competing land uses in a city that is striving to become denser while still remaining livable.

It is important to avoid the problems with soil compaction, reduced soil aeration, and erosion often associated with construction in order to protect existing trees and provide appropriate soil conditions to encourage tree growth and development.

Geographic variability in conditions that support urban forests

Conditions that support urban forests are not uniform across the city. The built environment limits space for trees, puts utility infrastructure in the path of growing trees, and fragments forest ownership across private property. Community members often differ in their opinions about tree-related amenities, view protection, and level of personal involvement in tree maintenance. These variable natural and human-influenced conditions can significantly impact the forest protection and restoration potential in different parts of the city, and don't neatly follow land use, neighborhood, or property boundaries.

Functional replacement limits of property-by-property tree replacement

The function of the original tree often is not replaced even when property owners who cut mid- to large-size trees are required to plant replacement trees on their property. There may be several reasons why functions are not replaced. It may be decades before a young replacement tree and its canopy reach the size of the original tree. Replacement trees on small lots may not have enough space to thrive. And to accommodate other uses of their property, owners may select smaller replacement species that provide fewer benefits. Property-by-property requirements could be enhanced if in some circumstances replacement occurred on nearby properties better able to

sustain groups of trees, larger species, and evergreens in the long term.

Maintenance by homeowners

Ongoing maintenance of trees can present a challenge for some residents. Expense and effort related to trees, from maintenance pruning to seasonal leaf litter removal, can be inconvenient or burdensome for homeowners. These issues apply to both trees in private yards and street trees.

Climate change

While trees help absorb climate change-causing gases, they are also subject to the impacts of a changing climate. Many plant species do not require a substantial change in their environmental conditions to be greatly affected. Recent research done by the University of Washington's School of Environmental and Forest Sciences found that ". . . regional climate projections suggest that plant hardiness zones in the Puget Sound region are likely to increase by a half zone towards the end of the century. The bioclimatic conditions that make up the current seed transfer zones around the Puget Sound for western red cedar, western hemlock, and Douglas fir are likely to diminish, shift further northwest towards Canadian islands, or disappear by the end of the century. This suggests that careful considerations should be made to diversify seed sources for restoration and reforestation of urban forests in the region and to adapt existing plan ecotypes to novel bioclimatic conditions in a changing climate."[14]

Views

One attribute that makes Seattle such a beautiful city is its views. Desire for views represents a major obstacle to encouraging more tree planting and preservation on private property in the hilly areas of the city. Similarly, neighborhood support for tree planting in the right-of-way where views may be affected is a major challenge. Because views involve distant locations, this issue crosses property lines and impacts a variety of areas with public and private trees. Views also are very subjective. While some people value completely unobstructed views, other people desire trees to frame their view.

Utilities

Conflicts between trees and utilities represent a challenge both for Seattle City Light (SCL) and Seattle Public Utilities (SPU). SCL prunes and removes trees for electrical safety and reliability and encourages replacement with species appropriate for planting under overhead wires to avoid such conflicts. In addition, water, sewer, gas, and other utilities located underground constrict the space for healthy tree growth. Tree roots of some species can damage sidewalks and make them unsafe for pedestrians. To address these issues, the City has developed a Master Tree List [15] to clarify which species may be appropriate in certain locations, as well as standards for locating trees near other infrastructure.

Tree roots can damage sidewalks and make them unsafe for pedestrians.

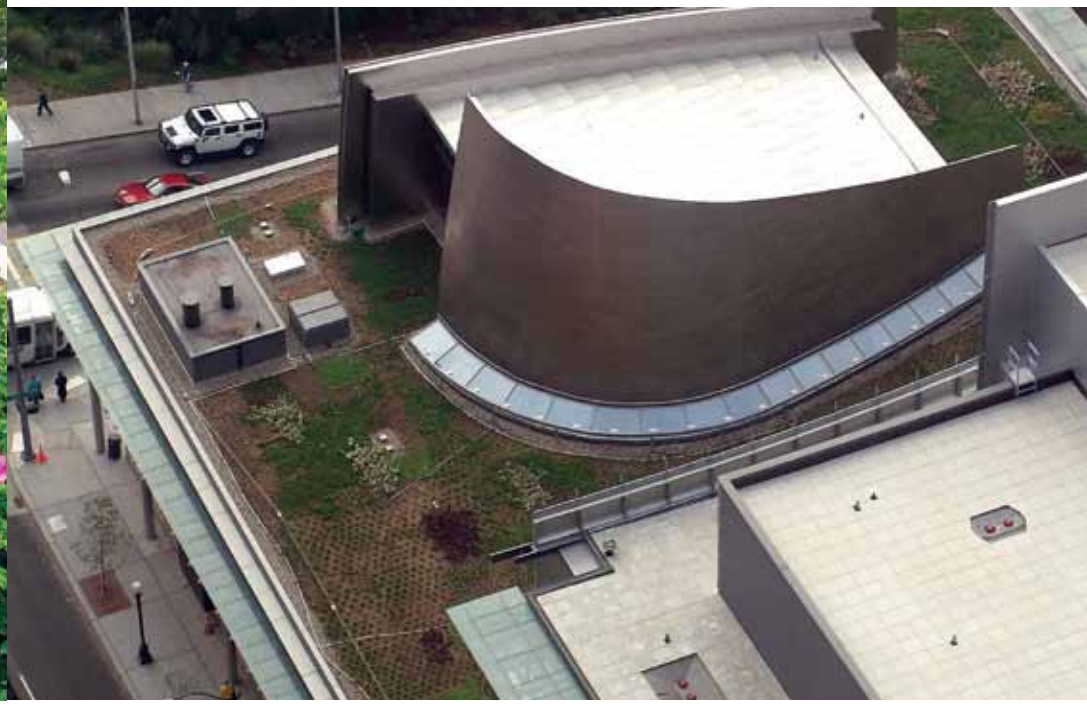
Seattle City Light prunes and removes trees for electrical safety and reliability and encourages replacement with species appropriate for planting under overhead wires.

[14] Kim, Soo-Hyung, Chung, Uran, Lawler, Joshua L. & Anderson, Royce E. 2012. Assessing the Impacts of Climate Change on Urban Forests in the Puget Sound region: Climate Sustainability for Tree Species. School of Environmental and Forest Sciences, College of the Environment, University of Washington.

[15] www.seattle.gov/trees/docs/2011-Master_Tree_List.pdf

Freight mobility

Commercial and industrial businesses in Seattle depend on the movement of goods by road, rail, and ship. The need for freight corridors as well as loading and staging areas can result in conflicts within the right-of-way, where trees can impact travel lanes and be damaged by moving trucks, as well as on private property, where businesses need flexible storage space on their lots, leaving very little land available for trees. Tree planting in freight corridors and industrial areas must consider the additional requirements and harsh conditions of these areas and avoid locations that do not provide adequate



planting space. Additionally, planting in these areas will be significantly more expensive than other areas due to the requirements of removing pavement, de-compacting soils, and creating curbs or other barriers to protect trees from freight.

Green roofs and green infrastructure

The high percentage of area given to buildings and parking lots creates a challenge for accommodating trees, but also creates opportunities for incorporating other strategies such as green roofs, swales, and pervious pavements. These low-impact development approaches should be encouraged but should also be carefully monitored to determine how they affect the opportunities for new trees through competition for space and the weakening of existing trees by changing soil and hydrology conditions.

Density and urban design

The denser areas of Seattle pose additional issues for accommodating trees. Residential developments must consider additional car parking, multiple

entrances, multiple private open space demands, more utility connections, and increased competition for light. Trees in business districts can create additional concerns about blocking signs or limiting area available for parking, gathering spaces, or other needs. Concerns about crime in the downtown core have also highlighted the need to design public landscapes that are safe and inviting by ensuring that trees allow clear sightlines and do not create dark areas. Considering trees early in the design process for new projects, buildings, and public spaces can help ensure that trees are seen as a necessary component of livability rather than an impediment to dynamic design.

Urban agriculture

Urban agriculture contributes to health and food security by increasing the amount of food that is grown and available in Seattle and by allowing fresh vegetables and fruit to be available for residents. Urban agriculture also contributes to community building. Seattle has been actively working on encouraging urban agriculture and increasing tree canopy could be considered a competing or complimentary use depending on tree planting location and the planting of fruit and nut trees.

Solar access

As energy costs increase and solar technology improves, solar panels as energy source alternatives are becoming more popular. Seattle residents are installing solar equipment both at home and in their businesses. Although Seattle is known for cloudy skies, it receives enough sunlight to make solar systems a feasible alternative. Mature trees provide important benefits but can also block the sun from solar installations. In addition, some homeowners remove trees to get more sunlight on their property.

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4 CURRENT STEWARDSHIP AND MANAGEMENT EFFORTS

CHAPTER 4

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This chapter describes existing programs and policies that different City departments have put in place to manage the urban forest resource. We also discuss stewardship efforts currently being implemented in Seattle.

Eight City departments have tree management responsibilities and are in charge of implementing the UFSP. Interdepartmental coordination is essential for effective management and consistent delivery of urban forestry programs. To that end, the City of Seattle formed the Urban Forest Interdepartmental Team (IDT) to provide a common base for coordinating development of policy, programs, and budgets that need city-wide direction (see Table 5). By providing an opportunity for staff to meet regularly, the IDT allows members to keep each other informed of and work together on actions that will impact the urban forest and that are either undertaken or proposed within their departments.

It is also important that similar communication exist between the City and other agencies such as the Port of Seattle, Army Corps of Engineers, King County, Washington State Department of Transportation (WSDOT), and even commercial entities such as the railroads.

Table 5. City of Seattle urban forest responsibilities by department

Department	Responsibilities
Department of Planning and Development (DPD)	Department of Planning and Development is responsible for the development, permitting, and enforcement of regulations for trees on private property both during and outside of the development process, including tree protection, landscaping, environmentally critical area, and nuisance requirements. DPD is also responsible for stewarding the City's Comprehensive Plan, which includes broad policy direction for managing the urban forest Contact: Public Resource Center, (206) 684-8467 (questions about regulations) Code Enforcement, (206) 615-0808 www.seattle.gov/dpd/trees
Finance and Administrative Services (FAS)	FAS manages properties and facilities owned or leased by the City. This includes buildings serving the Seattle Fire Department, Seattle Police Department, downtown City government office buildings, campuses housing City construction and heavy maintenance vehicles, various buildings throughout the community, as well as City-owned vacated property. Their goal is to preserve as many trees as possible on all sites, and to create sustainably landscaped areas around buildings and properties while ensuring the safety of tenants and property via proper tree planting, maintenance, and pruning. Contact: (206) 233-5104 www.seattle.gov/fas
Office of Sustainability and Environment (OSE)	Office of Sustainability and the Environment leads policy development and coordination for city-wide urban forest issues including management of the Urban Forest IDT, staffing of the Urban Forestry Commission, coordination of inter-departmental issues, reporting progress, and updating of the Urban Forest Management Plan. Contact: (206) 684-3194 www.seattle.gov/environment/urban_trees.htm
Seattle Center	Seattle Center manages trees on its 74-acre campus. It hosts hundreds of community events and three major festivals each year. There is constant pressure on the trees and landscape from resident organizations, promoters, and city residents. Contact: Landscape Supervisor, (206) 615-0880 www.seattlecenter.com
Seattle City Light (SCL)	Seattle City Light is responsible for ensuring safe and reliable power delivery through the comprehensive and environmentally responsible management of the trees and vegetation that their lines and infrastructure impact. City Light maintains an Urban Tree Replacement Program that works closely with the City's reLeaf program and its Trees For Neighborhoods program. City Light is challenged by a prevalence of inappropriately sized trees that grow into utility lines. Contact: Arboriculturist, (206) 386-1902 www.seattle.gov/light/vegetation
Seattle Department of Transportation (SDOT)	Seattle Department of Transportation is responsible for the management of trees in the right-of-way (street trees), including design, installation, and stewardship of trees and landscapes associated with public right-of-way and permitting of actions that could impact these trees. Since 2007, SDOT has planted an average of over 1,200 trees per year. SDOT also maintains over 40,000 street trees and regulates planting and maintenance of another 100,000 street trees. They must balance canopy cover goals with the need to minimize tree conflicts with surrounding infrastructure and transportation safety requirements. Contact: Urban Forest Manager, (206) 233-7829 City Arborist, (206) 615-0957 www.seattle.gov/transportation/forestry.htm
Seattle Parks and Recreation (Parks)	Seattle Parks and Recreation manages trees over 6,000 acres of developed parks, boulevards, natural areas, and other publicly-owned open spaces, including about 100,000 trees in developed parks and over 585,000 trees in the forested areas of parks. Parks must balance a wide range of recreational goals including the desire for picnic, sports, and play areas. Contact: Horticulture & Forestry Manager, (206) 684-4108 Senior Urban Forester, (206) 684-4113 www.seattle.gov/parks/horticulture
Seattle Public Utilities (SPU)	Seattle Public Utilities (SPU) works to maintain and restore the urban forest because it provides significant storm water mitigation benefits by intercepting and absorbing rainwater. Slowing the flow and improving water quality reduces the need for built infrastructure and mitigates flooding. SPU supports several programs that promote healthy urban forests including Restore Our Waters, the City's reLeaf program, Green Seattle Partnership and the Green Storm water Infrastructure program. SPU also maintains canopy cover on SPU-owned assets and through SPU capital projects. Contact: (206) 615-1668 www.seattle.gov/trees

Existing Programs and Policies

The UFSP is designed to impact a wide range of actions over time. This section focuses on the programs and policies currently in place to support Seattle's urban forest on public and private property, as well as on the right-of-way. These programs and policies are managed separately, but together comprise an integrated approach consisting of:

- Community Engagement and Stewardship
- Management of Public and Street Trees
- Management of Trees on Private Property

The Urban Forestry Commission was established in 2009 to advise the Mayor and City Council on issues related to Seattle's urban forest.

Community engagement and stewardship

The majority of Seattle's urban forest is located on private property. Consequently, broad appreciation for the benefits and needs of trees and engagement in the planning and policy development, planting, and care of trees is essential to the long-term health of this important asset. This section describes the ways in which the City engages the community in stewardship of the urban forest.

Planning and Policy Development

Seattle residents have the opportunity to participate in urban forest planning and policy development through public engagement in major plan updates, participation in oversight and planning committees, and discussions among the Board of Parks Commissioners, Planning Commission, Design Commission, and the Urban Forestry Commission.

The Urban Forestry Commission[16] was established in 2009 to advise the Mayor and City Council concerning the establishment of policy and regulations governing the protection, management, and conservation of

[16] Seattle reLeaf. Web www.seattle.gov/trees

trees and vegetation in the City of Seattle. The Urban Forestry Commission worked closely with the Urban Forest IDT on the update of this plan.

Outreach and engagement

The City plays an important role in fostering residents' understanding of the environmental, economic, and community benefits of trees, as well as providing information for residents regarding proper tree selection, planting, and care. City departments provide information through the City's website, the reLeaf website [17], brochures and other publications, environmental learning center activities, and during volunteer events.

The City's reLeaf program implements strategies to engage residents in urban forest stewardship. The program provides information and support for residents to understand the value of trees and how to care for them; facilitates access to urban forest organizations and events throughout the city; and works closely with City departments and community organizations to make urban forest outreach efforts accessible, understandable, and coordinated. The program maintains, develops, and delivers outreach tools and materials such as the reLeaf website, brochures, presentations, workshops, and trainings; engages Seattle residents in tree planting and stewardship; and leverages federal and state funds, along with thousands of volunteer hours through the Tree Ambassador, Urban Orchard Stewards, and Trees for Neighborhoods programs. Departments continue to work on achieving higher levels of coordination using reLeaf as their main outreach tool.

The Urban Forestry Commission holds open public meetings every month.

Volunteer opportunities

Seattle residents volunteer many thousands of hours each year in support of the City's urban forestry programs. Some of the key programs include:

[17] www.earthcorps.org/index.php

Figure 12. Tree Ambassador program participants learning to prune young trees

Green Seattle Partnership (GSP): Seattle has a serious invasive species problem. Over time, invasive species have the potential to completely replace native species, which provide more habitat and storm water benefits than invasive species do. Invasive shrubs and groundcovers can smother existing trees and prevent replacement trees from growing and, if unchecked, can result in the complete loss of trees. This is particularly true in our forested parklands, where the first generation of trees planted after logging is reaching maturity and trees are dying off at an elevated rate. Today, over 70 percent of Seattle's remnant forests have some invasive plants and about 50 percent are moderately to heavily invaded, according to data provided by the Seattle Urban Nature Project (now a part of EarthCorps).[18]

GSP is a partnership of the City of Seattle (Parks, SPU, and OSE), the non-profit Forterra, and thousands of volunteers, which helps leverage City resources and grants to restore 2,500 acres of forested parklands by 2025. Volunteers remove invasive species, plant trees, and maintain understory vegetation in forested parklands. Volunteers have contributed over 600,000 hours of work from the program's inception in 2005. Forest Stewards stand out as active volunteers and receive training in organizing and directing forest restoration, tree planting, and maintenance projects. Non-profit organizations such as Nature Consortium and Earth Corps have been important partners in this effort.

The Heritage Tree Program: This partnership between the City and Plant Amnesty, a local non-profit, works to identify and provide recognition for trees distinguished by botanical, historic, or landmark significance such as size, age, and uniqueness. Since 1993, a committee composed of Certified Arborists and residents have identified over 131 trees and three collections (Kubota Gardens, Arboretum, and University of Washington campus) that have been listed as Heritage Trees.

Traffic circle volunteers: SDOT recruits and trains volunteers to maintain over 1,000 traffic circles and other street-side landscaped areas.

Tree Ambassador Program: Seattle reLeaf's Tree Ambassador Program trains neighborhood leaders to become stewards of urban trees and engage their local community in tree planting and care. This is a SPU-led effort with strategic support from Parks, SDOT, and Forterra. Funding has been provided by a grant from the U.S. Forest Service's Urban and Community Forest Program.

[18] www.earthcorps.org/index.php

Figure13. Urban Orchard Stewards at a work party

Urban Orchards Stewards: This project works with residents to become stewards of existing public orchards. The work is being implemented through a partnership between Parks and non-profit City Fruit and has been funded by Washington State grant funds.

Many departments also work with business and community groups on a variety of planting, street repair, and design projects. By engaging with local businesses and groups on these projects, the City is able to get more done with limited funds and develop stewards who will continue to support the urban forest in their communities.

Management of public and street trees

The City of Seattle is directly responsible for management of trees in three management units: Parks' Natural Areas, Developed Parks, and Right-of-Way, as well as the management of trees on City property. Through this work, the City strives to implement the goals of the UFSP while also supporting other City goals, such as protecting public safety, facilitating mobility, accommodating recreational facilities, and providing vibrant open space.

Planting and establishment: The first three years of a tree's life, known as the establishment period, are typically the most maintenance intensive. Establishment requires attention to tree selection, site preparation, planting, watering, staking, pruning, and mulching to support tree survival. Street trees require additional watering because of the impervious paved surfaces that surround them. These surfaces also radiate heat increasing evaporation and decreasing water availability to the tree.

Each year, City departments plant new trees and follow the City's two-for-one tree replacement policy, under which departments are required to plant two trees for each tree they remove from City property. In 2012, City departments removed 500 trees as part of ongoing maintenance and hazard abatement efforts and planted over 3,200 trees, including 1,000 trees distributed to Trees for Neighborhoods program participants, thus fulfilling the two-for-one tree replacement policy.

The first three years of a tree's life, known as the establishment period, are typically the most maintenance intensive.

City of Seattle

Figure 14. Hazard response on street trees

Figure 15. Structural pruning in young trees is critical to establish safe, strong branches in mature trees

Pruning: Pruning is a specialized type of maintenance that can be done reactively to eliminate hazards such as obstructed traffic signs or removing branches at risk of falling (Figure 14). Pruning can also be done preventively for tree health and safety. Proactive pruning for health and safety is done to remove diseased or insect-infested wood, to improve air flow to reduce disease and insects, to remove crossing or rubbing branches (Figure 15) to remove broken limbs to encourage wound closure and prevent hazards, and to prevent obstruction of signs and pedestrian traffic. Pruning also helps the tree to develop a strong structure.

City staff and their contractors follow industry standards as defined in the International Society of Arboriculture's (ISA) tree pruning guidelines and/or those in the ANSI A300 pruning standards and the Z133.1 safety standards. Many of Seattle's urban forestry managers and tree-crew personnel are ISA Certified Arborists. An increasing number of arborists in the region's tree service firms are also ISA certified. Additionally, other specific practices are laid out in various departmental guides including the Parks Best Management Practice manual, the SDOT Street Tree manual, and other City landscaping and maintenance plans.

Pruning cycle — the length of time it would take a department to prune each of the trees for which they are responsible based on annual workload—is often used to measure the amount of care trees are receiving. Table 6 shows how current pruning cycles within each department compare to industry standards. One of the City's goals is for SDOT and Parks to approximate industry-standard pruning cycles.

Table 6. Estimated maintenance needs of City of Seattle trees

Department	Industry standard vs. current pruning cycle	# of trees department is responsible for
SDOT	5 – 7 Years vs. 13.4 years	40,000+ trees
Parks	5 – 7 years vs. 18 years	100,000 trees
SCL*	4 years*	n/a

*Utilities have no industry standard related to tree pruning cycle.

Due to limited resources, SDOT and Parks spend the majority of their time and resources on corrective measures and imminent hazard response. Deferred preventive maintenance for street trees and trees in Developed Parks is a key issue. Performing structural pruning of young trees is more cost effective than corrective pruning or pruning for hazards later.

Maintenance record keeping: Seattle has been working on improving maintenance records to facilitate workload planning. Having information available also assists greatly in answering questions from the public regarding how and where tree maintenance resources are being used.

SDOT currently uses a system that provides basic cost information about tree care operations and is working on integrating this information with their inventory data. Parks maintains data in a number of formats depending

upon the type of work and where it was performed. The Green Seattle Partnership Parks Forest Restoration Program has developed an online work-recording system that allows volunteers, contractors, and staff to enter work completed.

Managing woodwaste products: City urban forestry operations generate considerable amounts of byproducts from large logs to leafy compostable materials. These "waste" products are recycled in the form of mulch and compost. Higher-value woods are sold for specialty furniture or cabinetry. The City has a process in place for dealing with City-generated green waste on a broad scale.

Shared street tree management: While the City is responsible for all aspects of management for most of these trees, tree management responsibilities for street trees are often shared. Approximately 75 percent of street trees have been planted by private residents or community groups, and are therefore the responsibility of the abutting property owner to maintain. Many property owners are unaware of this responsibility or are unable or unwilling to maintain the trees. SDOT tree crews are frequently dispatched to prune or remove trees posing a risk to pedestrians and motorists that should be privately maintained. About 25 percent of crew time is spent responding to such calls.

SDOT tree crews are frequently dispatched to prune or remove trees posing a risk to pedestrians and motorists that should be privately maintained.

Management of public and street trees

The City encourages tree preservation and planting on private property areas over which it has no direct control through regulations, incentives, and outreach and engagement.

Regulations

The City has developed regulations and incentives with the following objective for trees on private property:

> To maintain and enhance a thriving and diverse urban forest that maximizes the environmental, economic, and social benefits of trees while recognizing other city-wide goals and policies for sustainability and growth management relating to density, transportation, housing affordability, and urban design and accommodating property owners' desires for solar access, solar energy, gardens, accessory structures, views, access, and risk management.

Under the existing code, regulations governing trees on private property are contained primarily in the following City codes:

- **Tree protection regulations**, Seattle Municipal Code (SMC) Chapter 25.11, which regulates tree removal both outside development and during the development process
- **Land use code**, SMC Title 23, which has standards for the planting of trees and vegetation included as part of the standards governing new development throughout the city
- **Environmentally Critical Areas (ECA) regulations**, SMC Chapter 25.09, which regulates trees and vegetation in and surrounding environmentally critical areas such as wetlands, streams, shorelines, landslide-prone areas, and associated buffers for ECA areas
- **Storm water code**, SMC Title 22 Subtitle VIII, which gives credit for trees and other green infrastructure in determining requirements for new development
- **Street and sidewalk use code**, SMC Title 15, which contains standards for the care of privately maintained street trees and permit requirements for planting, pruning, or removing street trees
- **Shoreline master program**, SMC title 23.60, which regulates development on the City's shorelines.

A summary of regulations affecting urban trees can be found at www.seattle.gov/dpd/trees. Revised tree protection regulations are currently being developed as the current regulations were intended to be interim.

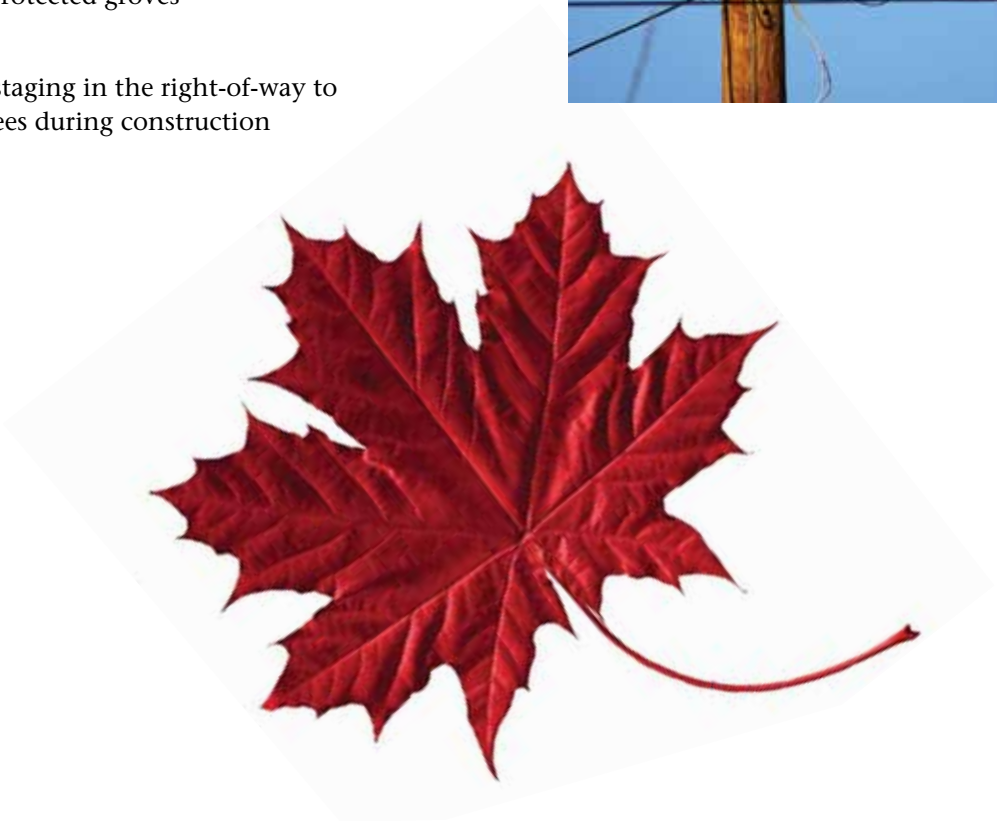
Incentives

The City also maintains a number of incentive programs to encourage planting and preservation of trees.

- **Development standard departures:** Applicants may apply for departures from development standards to preserve an existing tree during development.
- **Trees for Neighborhoods:** This reLeaf program provides free trees for Seattle residents to plant in their yards and planting strips. Program participants also receive free watering bags, training in proper planting and care, and ongoing tree care support. This program supported the planting of 2,300 trees between 2009-2011, including fruit trees, evergreen trees, small trees under power lines, and street trees.
- **Storm water rates:** SPU considers land cover in their calculation of storm water rates for larger property owners.

The City continues to seek opportunities for additional incentives. In the past, the City successfully partnered with private businesses to sponsor discount tree coupons that were popular and gave residents flexibility as to where trees were planted on their property. The tree-related incentives under consideration include:

- Subsidized tree expertise
- Storm water rate reductions for increased canopy or large trees
- Property rate reductions for protected groves
- Leaf management assistance
- Allowances for construction staging in the right-of-way to allow preservation of large trees during construction



5 A PATH FORWARD

Seattle's urban forest is a thriving and sustainable mix of tree and understory species and ages that creates a contiguous and healthy ecosystem that is valued and cared for by the City and all of its residents as an essential environmental, economic, and shared community asset that reinforces Seattle's identity and legacy as a forested, livable city.

CHAPTER 5

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This vision is aligned with Seattle Comprehensive Plan's core values of Community, Environmental Stewardship, Economic Opportunity and Security, and Social Equity. The Plan will strive, through its strategies and implementation actions, to support Seattleites in finding a sense of investment in and relatedness to urban trees and to maintain and enhance conditions necessary for a healthy natural environment by helping the City, residents, and businesses become stewards who share the responsibility to care for urban trees.

Goals

The UFSP seeks to improve the functions and benefits of Seattle's urban forests by protecting and restoring forest health and expanding canopy cover. The Plan's overarching goals are:

1. Create an ethic of stewardship for the urban forest among City staff, community organizations, businesses, and residents

2. Strive to replace and enhance specific urban forest functions and benefits when trees are lost, and achieve a net increase in the urban forest functions and related environmental, economic, and social benefits
3. Expand canopy cover to 30 percent by 2037
4. Increase health and longevity of the urban forest by removing invasive species and improving species and age diversity

Priority Actions to Support a Thriving Urban Forest

Particular focus is needed on specific priorities due to their importance related to forest functions and stewardship. These priorities were determined through the assessment of our urban forest's current state and the understanding of the conditions, both ecological and human, which support healthy trees. It is important to recognize that trees on private property make up a significant portion of the urban forest and policies and programs need to focus efforts in this area. The following priorities will assist in providing overall policy and programmatic direction.

Increase awareness of the value and proper care of trees

Urban forest stewardship requires the on-going engagement of government and the community. The success of our efforts is dependent upon informed actions and significant involvement by volunteers and residents.

Preserve existing trees

Because it takes decades for most trees to reach their ultimate size, trees already growing in Seattle generally provide immediate and ongoing benefits that cannot be matched by a small/young replacement tree. Exceptions may be trees planted in inappropriate places, or hazard, dead, or diseased trees.

Focus especially on:

- **Evergreen trees.** Because they maintain their canopy during the rainy season and are active year-round, evergreens can better attenuate rainfall, absorb carbon dioxide, and reduce air pollutants. Evergreen trees also are longer-lived than deciduous trees and tend to have much greater size potential.
- **Mid-Large trees.** Larger trees provide more environmental, cultural, and economic functions and benefits than smaller ones.
- **Groves of trees.** Compared to an individual tree surrounded by pavement or grass, groups of trees provide increased benefits by offering recreational opportunities, providing more diverse wildlife habitat, and creating duff soils on the forest floor that absorb storm water.
- **Unique wildlife habitat**. Higher quality habitat areas, such as heron rookeries, eagle nests, and salmon-bearing waters, are difficult to replace and can be impossible to replicate

Maintain existing trees

The health of existing trees is supported through proper and timely pruning and preventing invasive species.

Restore

A thriving urban forest is one that is not threatened by invasive species. Efforts to remove invasive species are crucial for the wellbeing of our forested parklands. It will be important to continue to engage residents and increase

awareness of the threat invasive species represent so that they are no longer planted on private property.

Plant new trees

Because trees age and die, urban forest regeneration requires replenishment of trees through human intervention. Active planting is needed to also ensure age and species diversity. In order for new trees to thrive, proper soil conditions, soil volume, appropriate location, water, and maintenance need to be provided. Consideration should be given to planting trees that maximize important functions and benefits, or replenish or enhance functions and benefits lost due to tree removal.

Strategies

In order to meet the goals of this plan, five overarching strategies were developed that represent a comprehensive approach to mobilizing informed

and effective action. These strategies derive from the integrated approach. Strategy 1 helps implement the community approach; Strategy 2 supports the ecological approach; and Strategies 3 – 5, represent the resource management approach.

1. **Inspire, inform, and engage** the community in active stewardship of Seattle's urban forest.
2. **Understand** the character and complexity of the urban forest resource.
3. **Coordinate** interdepartmental and interagency communication, cooperation, and decision-making.
4. **Preserve, restore, and enhance** the urban forest on City property.
5. **Regulate** private property to ensure minimum standards for care of the urban forest.

These strategies were used to develop the specific actions included in the action agenda.

Action Agenda

The action agenda outlines the steps that city and community partners will take to implement the UFSP. Department work plans focus on those aspects of the urban forest that each department can manage. For example, SDOT manages trees in the right-of-way while the Parks Department has primary responsibility for the developed parks and parks' natural areas management units.

The actions have been grouped according to the key strategies. The considerations used to develop the timeframe for each action include:

- **Feasibility.** Short-term actions to be completed by 2018 often are those that can be more easily implemented because they are partially implemented, budget neutral, or have agreed-upon new funding in place. Mid-term actions (5 to 10 years out) might require operational restructuring or reorganization, limited additional funding, or technological improvements on the part of internal or external partners. Long-term actions (more than 10 years out) may have significant budget implications, may involve organizational change, and/or may require significant fund raising.
- **Critical path toward priority action.** Some short- and mid-term actions are necessary precursors to, or components of, long-term actions that may not be feasible in the short-term but eventually could make substantial improvements to the urban forest. This ensures that initial steps toward potentially difficult but important actions are taken early.
- **Show progress.** To make tangible progress and maintain the confidence of these partners in plan implementation, small achievable action items should proceed at the same time as items yield more long-term results.

Table 7. Action Agenda for the Urban Forest Management Plan *continued*

Strategy	Short-term actions (1 - 5 years)	Mid-term actions (5 – 10 years)	Long-term actions (10+ years)
Inspire, inform, and engage the community about the benefits of the urban forest and proper tree care practices	**I1 - Strengthen city-wide approaches to communicating about trees. (SPU reLeaf)**	**I21** - Partner with nurseries and landscape industry to make quality information and plant materials available to the public, particularly information to discourage the sale of invasive plant species and encourage the use of native species. (SPU reLeaf)	**I27** - Develop community service opportunities with schools and other institutions for urban forest stewardship projects. (SPU reLeaf)
	I2 - Continue to provide resources about urban forestry to public through newsletters, permitting, websites, and other resources. (SPU reLeaf, IDT)	**I22** - Partner with realtors to distribute information as part of home purchase to make new buyers of property aware of their responsibility for maintenance of privately owned right-of-way trees. (SDOT)	**I28** - Continue exploring ways to Engage the community based on experience from implementation of existing programs. (SPU reLeaf, IDT)
	I3 - Revise materials to encourage "right tree in right place" but also encourage large trees and more diverse species where appropriate. (SDOT, SPU reLeaf)	**I23** - Provide adjacent property owners and tree service companies with the skills and knowledge to properly care for non-SDOT owned trees in the right-of-way. (SDOT)	**I29** - Explore mechanisms to collaborate with universities and the private sector on long-term urban forestry science. (OSE, SPU reLeaf)
	I4 - Provide materials on best practices for tree preservation during construction. (DPD)	**I24** - Create the mechanism that will allow an active partnership with the community service element of the Seattle Public Schools and other institutions. (SPU reLeaf)	
	I5 - Implement Green Seattle Urban Forestry tree curricula in K-12 schools. (Parks)	**I25** - Seek tree-planting opportunities with the cemeteries in Seattle. (SPU reLeaf)	
	I6 - Deliver education programs such as Forestry U to all communities to engage traditionally underserved neighborhoods. (Parks)	**I26** - Institute a program to acknowledge and publicize contributions to urban forestry by residents, businesses, institutions, and neighborhood group organizations. (SPU reLeaf, IDT)	
	I7 - Provide information about trees that thrive in harsh conditions. (SPU reLeaf, DPD, SDOT)		
	I8 - Continue to identify special trees and mark their historic, biological, or other traits with signs or other means through the Heritage Tree Program. (SDOT)		
	I9 - Work closely with Urban Forestry Commission on development of policies and programs to implement and achieve UFSP goals. (OSE, IDT)		
	I10- Engage the public in developing UFSP updates. (OSE, IDT)		
	I11 - Use the results of a new tree canopy cover study to analyze distribution of canopy cover across residential areas and how the distribution relates to factors such as income. (OSE, IDT)		
	I12 - Analyze current diversity of participants in City-sponsored urban forest engagement program and develop strategies to engage under-represented groups. (SPU reLeaf)		
	I13 - Work with local universities to pursue the research agenda. (OSE, IDT)		
	I14 - Provide residents the opportunity to plant trees on Parks' property to commemorate major life events. (Parks)		
	I15 - Establish a process to obtain input from Friends of Seattle's Olmsted Parks on efforts relating to Olmsted-designed parks in Seattle. (Parks)		
	I16 - Expand volunteer stewardship opportunities through the Green Seattle Partnership, "Friends of" groups, Tree Ambassador, and other programs. (OSE, Parks, reLeaf, SDOT)		
	I17 - Consider expansion of Neighborhood Business District grants for tree planting. (SDOT, SPU reLeaf)		
	I18 - Use the Major Institution Master Planning process to identify opportunities for planting and preserving trees. (DPD)		
	I19 - Work with private property owners and major public industrial operators to explore tree-planting opportunities in industrial areas. (OSE, SPU reLeaf, DPD, SDOT)		
	I20 - Provide opportunities for education-based groups such as fraternities, sororities, and clubs to become involved with planting trees on their campuses. (SPU reLeaf)		

Table 7. Action Agenda for the Urban Forest Management Plan

Strategy	Short-term actions (1 - 5 years)	Mid-term actions (5 – 10 years)	Long-term actions (10+ years)
Understand the characteristics and complexity of the urban forest resource	**U1 - Conduct city-wide canopy cover assessment every five years. Calibrate results to previous assessments and conduct change analysis. (OSE)**	**U14** - Develop better indicators for city-wide survey of species distribution, age distribution, and tree health. (OSE, IDT)	**U21** - Develop cross-departmental measures and deliverables for the reduction of fragmentation effects on wildlife and urban forests. (OSE, IDT)
	U2 - Assess cost of conducting tree sampling every five years. (OSE)	**U15** - Evaluate potential of ecological corridor planning. (OSE, IDT)	
	U3 - Analyze Seattle i-Tree survey data to better understand existing conditions of our urban forest. (Parks, IDT)	**U16** - Capitalize on research being done by others in order to quantify the financial value associated with the social benefits afforded by the urban forest. Monetize these benefits based on best available science. (OSE, IDT)	
	U4 - Analyze tree planting potential data for all management units. Conduct pilot to ground-truth information. (OSE, IDT)	**U17** - Complete tree inventory of developed parks. (Parks)	
	U5 - Conduct a GIS evaluation to further define the forest protection/restoration potential of different neighborhoods. (OSE, IDT)	**U18** - Develop forest ecosystem service, resilience, and sustainability measures that define a restored status for urban forests. (Parks)	
	U6 – Eco-hoods (OSE, IDT): • **Analyze options for designating eco-hoods for units for urban forest management.** • **Explore feasibility of incorporating this concept into existing policies and programs and the next 5-year update of the Plan.** • **Consider how eco-hoods and management units could be integrated or connected as part of existing policies and programs and a future plan update.**	**U19** - Develop dynamic inventory processes that can be updated and maintained for street and park trees. (Parks, SDOT)	
	U7 - Evaluate habitat corridor and waterways gaps in the industrial management unit. (DPD)	**U20** - Develop dynamic inventory processes that can be updated and maintained for street and park trees. (SDOT, Parks)	
	U8 - Continue to regularly update forest typing in Parks' Natural Areas. (Parks)		
	U9 - Continue to develop modeling for tree ages, sizes, and life expectancy, accounting for species and site factors, to estimate management needs and costs in natural areas. (Parks)		
	U10 - Increase the resilience and sustainability of forested lands through further research in species composition and serial succession patterns in urban settings. (Parks)		
	U11 - Continue to update SDOT street tree inventory. (SDOT)		
	U12 - Develop and map fish and wildlife conservation areas using best available science based on Sensitive Areas Ordinance and Growth Management Act requirements. (DPD, IDT)		
	U13 - Develop methodology and decision tool to determine appropriate replacement of functional benefits over time lost due to mid-large sized tree removal by the City or residents. (OSE, Parks, SDOT, IDT)		

Table 7. Action Agenda for the Urban Forest Management Plan *continued*

Strategy	Short-term actions (1 - 5 years)	Mid-term actions (5 – 10 years)	Long-term actions (10+ years)
Coordinate interdepartmental and interagency communication, cooperation, and decision-making	**C1 - Continue to convene the Urban Forest Interdepartmental Team as the group primarily responsible for implementing the UFSP through the work of the represented departments. (OSE, IDT)**	**C7** - Assess feasibility and potential impacts of creating a city-wide policy regarding trees and views. (OSE, IDT)	**C8** - Conduct urban forestry activities as a city-wide program with a de-emphasis on the roles of specific departments. (OSE, IDT)
	C2 - Continue to identify and address interdepartmental policy and project issues. (OSE, IDT)		**C9** - Review urban forestry staff functions, roles, and responsibilities with an eye toward achievement of management efficiencies. (OSE, IDT)
	C3 - Integrate urban forest management planning with other City efforts affecting vegetation, such as Green Storm water Infrastructure, Green Factor, etc., open spaces, and sustainable development. (OSE, IDT)		
	C4 - Develop decision-making tools related to tree retention or removal decisions where infrastructure conflicts exist. Develop methods to allow removal and replacement with appropriate species in appropriate locations. (OSE, IDT)		
	C5 - Develop a monitoring framework and robust set of indicators to track progress on achieving the Plan's goals. (OSE, IDT)		
	C6 - Build cross-departmental goals for habitat connectivity between forest fragments. (OSE, IDT)		

Table 7. Action Agenda for the Urban Forest Management Plan *continued*

Strategy	Short-term actions (1 - 5 years)	Mid-term actions (5 – 10 years)	Long-term actions (10+ years)
Preserve, restore, and enhance the urban forest on City property	**Planning and design:** **P1 - Develop policy to prioritize expenditures for outreach and education; maintenance, preservation, and restoration; and planting. (OSE, IDT)**	**P27** - Diversify seed sources for restoration and reforestation of urban forests in the region in order to adapt existing plant ecotypes to novel bioclimatic conditions in a changing climate. (OSE, IDT)	**P33** - Take advantage of utility repair and replacement work being done and consider removing underground utilities from planting strips to increase street tree planting opportunities. (SDOT)
	P2 - Continue to revise and update City best-management practices for tree and forest maintenance on a 5-year cycle. (OSE, IDT)	**P28** - Develop an urban forest maintenance plan for street trees. (SDOT)	
	P3 - Develop metrics for soil volume, soil compaction, soil type, species diversity, and hydrologic information to help create sustainable forests requiring less maintenance. (OSE, IDT)	**P29** - Develop a risk assessment plan for street trees. (SDOT)	
	P4 - Design public spaces to maintain clear sightlines and avoid creating dark, unwelcoming spaces. (SDOT, Parks, DPD)	**P30** - Work across departments to restore forest composition, structure, and function in rights-of-way. (SDOT)	
	P5 - Implement a hazard tree abatement program for street trees. (SDOT)		
	P6 - Encourage understory plantings in tree planting projects. (SDOT, DPD, Parks, Seattle Center FAS, SPU)		
	P7 - Explore opportunities to maximize available planting space by using existing and new technologies such as root barriers, Silva Cells, and/ or specialized soil mixes. (SDOT, DPD, Parks, Seattle Center FAS, SPU)		
	P8 - Expand the use of tree planting strips rather than tree pits with grates to provide greater rooting area and enhanced storm water mitigation. (SDOT, DPD, Parks, Seattle Center, FAS, SPU)		
	P9 - Evaluate five years of Seattle City Light pruning for safety and reliability work expenditures and make an analysis comparing impacts from ongoing pruning to major removal. (SCL, SDOT)		
	Planting: **P10 - Plant a minimum of two trees for each tree removed across all departments. (OSE, IDT)**		
	P11 - Explore feasibility of increasing fruit and nut tree planting and/or establishment of community orchards on Seattle public lands. (OSE, Parks, FAS)		
	Maintenance: **P12** - Provide public education and outreach regarding reasons for tree removals as part of large City projects. (OSE, SPU, reLeaf, DPD, Parks, Seattle Center, FAS)	**P31** - Seek to reduce pruning cycle to industry standards. (Parks, SDOT)	
	P13 - Improve management and harvesting of existing fruit- and nut-bearing trees on existing City-owned property. (OSE, Parks, FAS)		
	P14 - Identify and prioritize removal of invasive species from non-Parks City properties. (OSE, FAS, Seattle Center, SCL, SPU)		
	P15 - Seek to combine maintenance of adjacent areas such as shoreline street ends and street trees to reduce overall costs. (SDOT, Parks)		
	Tracking: **P16 - Develop consistent methodologies for tracking and reporting tree work and for performance metrics. (OSE, Parks, SDOT, SCL)**	**P32** - Develop reporting methodology that can support a dynamic inventory process. (Parks, SDOT)	**P34** - Link work record system with inventory so updates are continuous. (Parks, SDOT)
	P17 - Purchase or develop a tree management software system to track work performed on publicly owned trees. (Parks, SDOT, SPU)		
	P18 - Continue development of database management tools to assist with monitoring, documentation, and evaluation of forest restoration work. (Parks)		
	P19 - Link Vegetation Management Plan establishing hazard tree needs to the Work Order System prioritizing tree removals. (Parks)		
	Funding: **P20 - Develop tools for measuring and monetizing the comprehensive benefits provided by a healthy urban forest in Seattle. (OSE, IDT)**		
	P21 - Use asset management and triple bottom-line cost-benefit analysis in assessing urban forest related projects. (OSE, IDT)		
	P22 - Explore options for dedicated funding sources for street trees. Explore creative financing mechanisms to ensure alternative funding to supplement general fund revenues. (SDOT)		
	P23 - Develop a coordinated approach to seek funding from sources such as local and regional foundations, industry, and corporations. (OSE, IDT)		
	P24 - Work with the business and non-profit communities (e.g., Seattle Parks Foundation) to create a tree donation account or other funding strategies. (OSE, IDT)		
	P25 - Explore funding opportunities with the business community and with regional donors, particularly for special projects identified in a management plan. (OSE, IDT)		
	P26 - Explore creative financing mechanisms to obtain funding for City urban forestry programs. (OSE, IDT)		

Table 7. Action Agenda for the Urban Forest Management Plan *continued*

Strategy	Short-term actions (1 - 5 years)	Mid-term actions (5 – 10 years)	Long-term actions (10+ years)
Regulate private property to ensure minimum standards for care of the urban forest	**R1 - Improve design of street tree pits, including standards for soil volume, soil composition, and minimizing issues with tree grates. (SDOT)**	**R8** - Continue to evaluate the effectiveness of incentives and regulations and make changes on a regular basis. (OSE, DPD, IDT)	**R12** - Consider burying certain overhead utility lines to increase street tree planting opportunities. (SCL, SDOT)
	R2 - Update existing regulatory framework to promote the goals of the UFSP and mitigate the impacts of development, while providing flexibility for property owners to balance multiple goals and competing uses. (DPD)	**R9** - Explore opportunities to modify storm water rates to better reflect the value of trees. (SPU)	
	R3 - Continue to engage community stakeholders to identify opportunities and barriers for tree planting and preservation on private property. (SPU – reLeaf)	**R10** - Explore opportunities for allowing staging in the right-of-way to allow additional tree retention. (DPD, SDOT)	
	R4 - Explore opportunities to expand the range of incentives available for tree planting and retention, including job programs, and technical assistance. (SPU - reLeaf, Parks)	**R11** - Consider expanding and tailoring Trees for Neighborhoods programs to serve business and industrial areas. (SPU - reLeaf)	
	R5 – Explore options for increasing canopy on Industrial Landscape Streets, riparian areas, and commercial properties. (SDOT, DPD)		
	R6 - Consider opportunities for protecting significant groves of trees through Environmental Critical Areas Update. (DPD)		
	R7 - Train staff in tree protection practices. (DPD)		

Monitoring

This Plan is designed to actively guide City actions, departmental work plans, budget proposals, and efforts by the City's community partners. Keeping efforts on track will require regular check-ins on the progress of plan implementation.

A monitoring framework will be more thoroughly developed as part of the action agenda. Monitoring will be used to evaluate Seattle's urban forest efforts and update the Plan to make actions even more effective over time.

The framework will address the following aspects of the Plan and the urban forest:

- **Plan implementation.** This Plan is designed to actively guide City actions, departmental work plans, budget proposals, and efforts by the City's community partners. Keeping efforts on track will require regular check-ins on progress implementing City urban forest programs, including the action agenda. For example, to monitor progress on an action agenda item, such as planting two trees for every tree removed by a City department, implementation monitoring would identify whether two trees were actually planted each time.
- **Effectiveness.** Once developed, the monitoring framework also would measure whether actions are achieving expected results, answering questions such as: How much did the two-for-one tree planting program contribute toward achieving the 30-percent forest canopy goal?
- **Performance**. Plan results ultimately will be measured by whether Plan goals, such expanding the forest canopy to 30 percent, achieve desired forest functions such as wildlife habitat or air quality improvement.

This work resulted in a goal of increasing canopy cover to 30 percent by 2037.

Indicators

Although baseline data are available to track progress toward the Plan's canopy cover goals, sufficient information is not yet available as a baseline for tracking improvements in forest health and function. Indicators can be used to establish a baseline and track changes in forest function, extent, and health.

Forest function indicators

Not enough baseline information is available at this time to establish quantitative goals for forest function. The City will seek to conduct regular sample-based inventories of public and private trees to help build that information over time. Although indicators for measuring forest function may emerge from those inventories, functional indicators often are more difficult to identify and measure than those for canopy cover and forest health. For example, indicators of urban forest wildlife functions might include indicators related to the animals themselves (number, diversity, and health of various wildlife species), as well as indicators of the habitat on which they rely. The complexity and number of indicators could be multiplied by the many functions the forest provides. As a result, development of functional indicators may require a longer time frame than indicators of canopy cover and forest health.

Canopy cover indicators and management unit goals

The IDT developed canopy cover goals as part of developing the initial version of the UFSP in 2007. In developing these goals, the IDT considered the following factors to define an ambitious but realistic goal for the UFSP planning horizon:

- Land-use mix in Seattle and other City land-use goals (e.g., encouraging density, facilitating freight mobility, etc.);
- Estimated 2007 canopy cover and general planting opportunities;
- American Forests' recommendations as benchmarked against other cities;
- Advice from external experts from other cities, consultants, the University of Washington, and the public.

This work resulted in a goal of increasing canopy cover to 30 percent by 2037, as well as establishing canopy cover goals by management unit (Table 8). It should be noted that the level of uncertainty in existing canopy cover estimates for individual management units has not been determined due to limited funding for field verification, so these goals represent scales of magnitude rather than exact figures.

In developing the 2013 UFSP, the canopy cover goals were not changed despite updated data on estimated canopy cover.

The IDT felt the canopy cover goals were intended to establish long-term goals and that it was preferable to wait for more data points before adjusting the goals. The IDT anticipates updating these goals as part of the next update of the UFSP, when new canopy cover assessments and more detailed planting potential analysis will be available. Consequently, the canopy cover goals by management units should be seen as general guideposts for success rather than specific targets for charting annual progress or for prioritizing work.

Table 8. Canopy cover goals by management unit

Management unit	MU as % of total city land area	Estimated 2007 canopy cover	2037 canopy cover goal
Single-Family	56%	26%	33%
Multi-Family	11%	17%	20%
Commercial/Mixed Use	8%	10%	15%
Downtown	1%	9%[1]	12%
Industrial	11%	4%	10%[2]
Institutional	2%	19%	20%
Developed Parks	4%	25%	25%
Parks' Natural Areas	7%	80%	80%
City-Wide		23%	30%
Right-of-Way[3]	27%	18%	24%

[1] The assessment of 2007 satellite data measured downtown canopy at 5%. The process encountered difficulties measuring downtown due to tall buildings casting shadows over trees. SDOT did an analysis of their inventory and estimated that current downtown canopy cover is closer to 9 percent.

[2] The assessment of 2007 satellite data suggested higher canopy cover levels than had previously been expected for all management units except for the industrial, which decreased from 8 percent to 4 percent. However, canopy cover goals for management units were not changed as part of this UFSP update. Consequently, the difference between the current canopy and the goal was increased but this shift is not intended to represent a change in the City's overall strategy and the canopy cover goal will be reevaluated as part of the next UFSP update.

[3] Right-of-way trees are also included in each of the land-use types

Forest health indicators

Unlike the 30 percent canopy cover goal, the City does not have sufficient long-term data to establish a quantitative goal for urban forest health including longevity, age diversity, and species diversity.

While baseline information is being developed, guidance can be taken from studies that are not specific to Seattle's landscape. For example, urban forestry professionals advocate for the use of no more than 10 percent of any one species or cultivar, and no more than 20 percent of any genus or 30 percent of any family. These are good general guidelines to follow, and efforts should be made to educate residents and tree suppliers on the value of a diverse plant palette. The key to sustainability in urban forests lies not in the selection of any single "ideal tree" with a particular set of characteristics but in biological diversity within urban plantings in order to minimize plant maintenance needs, as well as minimize losses that are the result of monoculture plantings or overuse of a genus or species. Seattle's native forest species are well adapted to the Pacific Northwest and are suitable for planting across the city. Species diversity should also address survivability and adaptability to current and future conditions.

Age diversity will result naturally if the City has a sustained planting and replacement plan. Seattle has a fairly young street tree population, and as long as trees are selected that have reasonable longevity, age diversity should be of less concern than species diversity.

Typically, "approved tree lists" do not have numerical restrictions on species that might be overplanted.

The most commonly planted species are generally those that are available in large quantities at numerous retail locations. Striving to replace 1 to 2

Urban forestry professionals advocate for the use of no more than 10 percent of any one species or cultivar, and no more than 20 percent of any genus or 30 percent of any family.

percent of our trees every year will result in a more diverse age distribution that will support sustainability of our urban forest. Seattle's Master Tree List can be found on the reLeaf website.[19]

To help develop quantitative forest health goals and indicators, the City will seek to conduct regular sample-based inventories of public and private trees indicating tree conditions and risk level. The following indicators for measuring forest health (adopted from Clark et al., 1997) may emerge from those inventories:

- Age distribution of trees, as indicated by the percent of trees of various diameters
- Species suitability for Seattle's climate and tree location, in terms of percent of suitable species
- Species distribution as indicated by the variety of tree species, prevalence of native species, and the percent of invasive species
- Condition of publicly owned trees and publicly owned wooded natural areas

While indicators are being developed, the City will continue to communicate the value of diversity and the high prevalence of certain types of trees that are currently overplanted in order to support the overall goal of increasing the diversity of our urban forest. The City also will engage residents to avoid planting invasive species and to continue to support programs such as the Green Seattle Partnership, which works to remove invasive plants from our urban forest over time to the point where routine maintenance will be sufficient.

Funding

Implementation of the action agenda will require policy, program, and budget coordination, as well as long-term and stable funding.

In order to establish adequate and sustainable funding for urban forestry efforts, the City will consider the following:

- Develop tools for measuring and monetizing the comprehensive benefits provided by a healthy urban forest in Seattle.
- Use asset management and triple bottom-line cost-benefit analysis in assessing urban forest related projects.
- Explore options for dedicated funding sources for street trees. Explore creative financing mechanisms to ensure alternative funding to supplement general fund revenues.
- Develop a coordinated approach to seek funding from sources such as local and regional foundations, industry, and corporations.
- Work with the business and non-profit communities (e.g., Seattle Parks Foundation) to create a tree donation account or other funding strategies.
- Explore funding opportunities with the business community and with regional donors, particularly for special projects identified in a management plan.
- Explore creative financing mechanisms to obtain funding for City urban forestry programs.

[19] www.seattle.gov/trees/docs/2011-Master_Tree_List.pdf

6 FUTURE RESEARCH NEEDS

During During ongoing management of the urban forest and development of this plan, the City has identified multiple areas in which the City and urban forest managers in general could benefit from additional knowledge. The following are specific research areas that are beyond the ability of the City to develop at this point in time, but would be excellent opportunities for universities or other research groups to explore in order to support greater knowledge for the field:

1. Develop tools for understanding the complete life-cycle costs of deferred tree planting and maintenance.
2. Develop tools for comparing the costs and benefits of maintenance using different pruning cycles.
3. Develop comprehensive systems for monetizing urban forest benefits (e.g., ecosystems, storm water, health, crime reduction, business) based on local conditions. In particular, the following elements are found to be particularly problematic in assessing monetary benefits:
   a. Public health benefits
   b. Energy benefits including summer cooling, winter solar access, and wind reduction
   c. Climate-change impacts over complete life-cycle of trees depending on final end uses (decomposition, wood chipping, commercial harvest).
4. Develop a more detailed method for quantifying storm water and water-quality benefits for individual trees and trees in forested parklands based on canopy, species, location, etc.
5. Analyze research that provides quantitative data on the benefits of trees as a Race and Social Justice issue for community improvement and cultural engagement.

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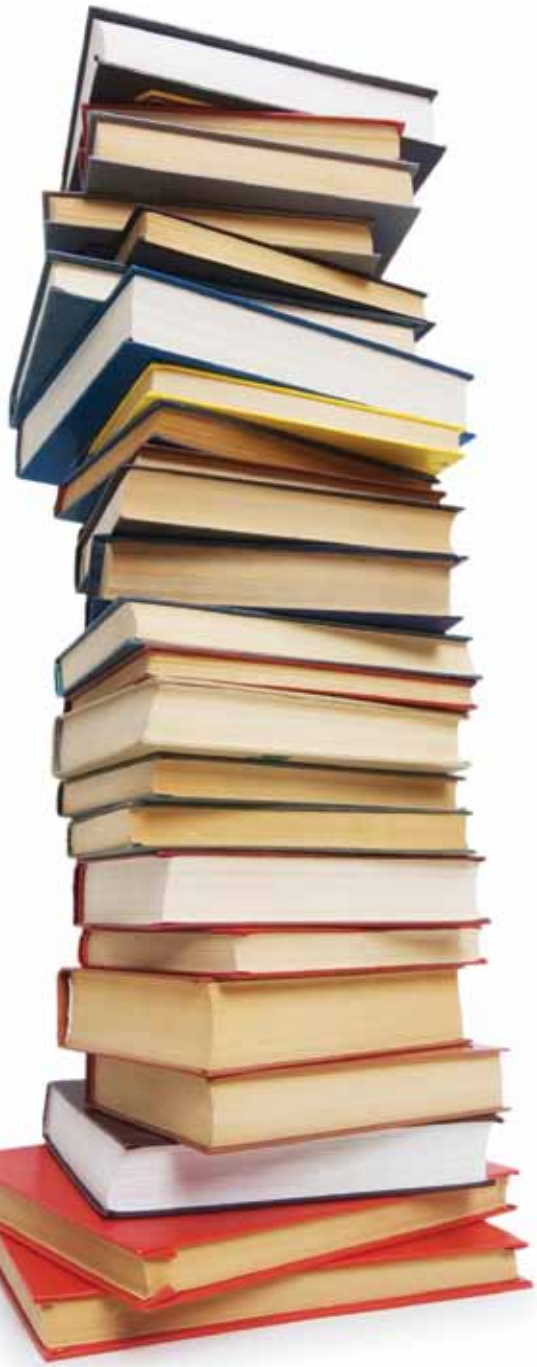
Appendix 1: Bibliography



American Forests. 1998. Regional Ecosystem Analysis Puget Sound Metropolitan Area. Seattle, WA.

American Forests. 1999. Urban Ecosystem Analysis of Seattle, Washington. Seattle, WA.

Bratton, N.J & K.L. Wolf. 2005. Trees and Roadside Safety in U.S. Urban Settings, Paper 05-0946. In Proceedings of the 84th Annual Meeting of the Transportation Research Board (January 9-13, 2005). Transportation Research Board of the National Academies of Science. Washington, DC.

Clark, J. R., N. P. Matheny, G. Cross & V. Wake.1997. A Model of Urban Forest Sustainability. *Journal of Arboriculture.* 23 (1): 17-30.

Donovan, Geoffrey H., et al. The Relationship between Trees and Human Health. Evidence from the Spread of the Emerald Ash Borer." *American Journal of Preventive Medicine.* 2013; 44(2):139-145.

Donovan, Geoffrey H., Jeffrey P. Prestemon. 2012. The effect of trees on crime in Portland, Oregon. *Environment and Behavior.* 44(1): 3-30.

Donovan, Geoffrey H., David T. Butry. 2010. Trees in the city: Valuing street trees in Portland, Oregon. *Landscape and Urban Planning.* 94: 77-83.

Fazio, Dr. James R. "How Trees Can Retain Stormwater Runoff." Tree City USA Bulletin 55. Arbor Day Foundation. 2010. Web: www.fs.fed.us/psw/programs/uesd/uep/products/11/800TreeCityUSABulletin_55.pdf

Foster, Josh, Ashley Lowe, and Steve Winkelman. The Value of Green Infrastructure for Urban

Climate Adaptation. Rep. Center for Clean Air Policy, 2011. Web: www.ccap.org/docs/resources/989/Green_Infrastructure_FINAL.pdf

Gilman, Edward & Sharon Lilly. 2002. Best Management Practices: Tree Pruning. International Society of Arboriculture. Champaign, IL.

Green Cities Research Alliance, August 2012. Seattle's Forest Ecosystem Values. Analysis of the Structure, Function, and Economic Benefits.

Heifetz, Ronald. 1994. Leadership without Easy Answers. Harvard University.

Kenney, W. Andy, van Wasseanaer, Philip J.E., & Satel, Alexander L. 2011. Criteria and Indicators for Strategic Urban Forest Planning and Management. *Arboriculture & Urban Forestry.* 37(3): 108-117.

Kim, Soo-Hyung, Chung, Uran, Lawler, Joshua L. & Anderson, Royce E. 2012. Assessing the Impacts of Climate Change on Urban Forests in the Puget Sound region: Climate Sustainability for Tree Species. School of Environmental and Forest Sciences, College of the Environment, University of Washington.

Kuo, F.E., Sullivan, W.C., Coley, R.L., & Brunson, L. (1998). Fertile ground for community: Inner-city neighborhood common spaces. *American Journal of Community Psychology.* 26(6): 823-851.

McPherson, E.G., Simpson, J.R., Peper, P.J., Xiao, Q. 2011. Trees pay us back in the Pacific Northwest region. Pacific Southwest Research Station, USDA Forest Service. Web: www.fs.fed.us/psw/programs/uesd/uep/products/18/812uesd_uep_tpub_PacificNorthwest.pdf

McPherson, E.G., S.E. Maco, J.R. Simpson, P.J. Peper, Q. Xiao, A.M. VanDerZanden and N. Bell. 2002. Western Washington and Oregon Community Tree Guide: Benefits, Costs, and Strategic Planting. Silverton, OR: International Society of Arboriculture, Pacific Northwest. Web: www.fs.fed.us/psw/programs/uesd/uep/products/5/CUFR_164_Western_WA_OR_Tree_Guide.pdf

Miller, R.W. 1997. Urban Forestry: Planning and Managing Urban Green Spaces. Prentice Hall. Upper Saddle River, NJ.

Nowak, David J., Susan Stein, Paula Randler, Eric Greenfield, Sara Comas, Mary Carr, and Ralph Alig. "Sustaining America's Urban Trees and Forests." *U.S. Department of Agriculture, Forest Service, Northern Research Station.* (2010) Web: www.fs.fed.us/openspace/fote/reports/nrs-62_sustaining_americas_urban.pdf

Nowak, David J., Daniel E. Crane, Jack C. Stevens, Robert R. Hoehn, Jeffrey T. Walton, and Jerry Bond. "A Ground-based Method of Assessing Urban Forest Structure and Ecosystem Services." *Arboriculture & Urban Forestry* 2008. 34(6): 347-358. Web: www.itreetools.org/eco/resources/08%20UFORE.pdf

Poe, Melissa R., Rebecca J. McLain, Marla Emergy, and Patrick T. Hurley. Urban Forest Justice and the Rights to Wild Foods, Medicines, and Materials in the City. *Human Ecology.* 2013.

Rodgers, Randy. "Philadelphia Plans for Green City, Clean Water." Sustainable City Network. 01 June 2011. Web: www.sustainablecitynetwork.com/topic_channels/water/article_b296460c-8caa-11e0-93e0-001a4bcf6878.html

SUNP. Seattle Urban Nature Project. 2004. 16th Int'l Conference, Society for Ecological Restoration, August 24-26, 2004, Victoria, B.C. Canada. A Citywide Survey of Habitats on Public Land in Seattle: a Tool for Urban Restoration Planning and Ecological Monitoring. Matthew Ramsay, Nelson Salisbury, and Suzi Surbey. Seattle, WA.

SUNP. Seattle Urban Nature Project. 2000. Seattle Public Lands Habitat Summary. Seattle, WA.

Thaler, Jordan. "The Environment, Financial and Health Benefits of Urban Forestry." Web log post. Center for City Parks Excellence. The Trust for Public Land, 25 Mar. 2011. Web: http://cityparksblog.org/2011/03/25/the-environmental-financial-and-health-benefits-of-urbanforestry

The Trust for Public Land. "The Economic Benefits of Seattle's Park and Recreation System. Center for City Park Excellence. March 2011. Web: http://cloud.tpl.org/pubs/ccpe-seattle-park-benefits-Report.pdf

Troy, Austin, Grove, J. Morgan, O'Neil-Dunne, Jarlath. 2012. The Relationship between tree canopy and crime rates across an urban-rural gradient in the greater Baltimore region. *Landscape and Urban Planning.* Volume 106, Issue 3, 15 June 2012. Pages 262-270

University of Washington, College of Forest Resources. Urban Forest Values: Economic Benefits of Trees in Cities. Rep. Center for Human Horticulture, 1998. Web: www.cfr.washington.edu/research/factSheets/29-UrbEconBen.pdf

Victurine, R., A. Wagar, K. Wolf, S. Brace, R. Corletta. 2001. A City Among the Trees: *A Strategic Plan for Seattle's Urban Forest.* Technical Report by the Cascadia Consulting Group submitted to the City of Seattle. Seattle, WA.

Victurine, R., A. Wagar, K. Wolf, S. Brace, R. Corletta. 2000. *Seattle Urban Forest Assessment: Sustainability Matrix and Report.* Technical Report by the Cascadia Consulting Group submitted to the City of Seattle. Seattle, WA.

White, Rachel E., Geoffrey H. Donovan, Jeffrey P. Prestemon. 2011. Trees thwart shady behavior. *Nursery Management and Production.* February: 30-33.

Wolf, K. L. 1998. Enterprising landscapes: Business districts and the urban forest. *In* C. Kollin (ed.), Cities by nature's design: Proceedings of the 8th National Urban Forest Conference, Washington, DC: American Forests.

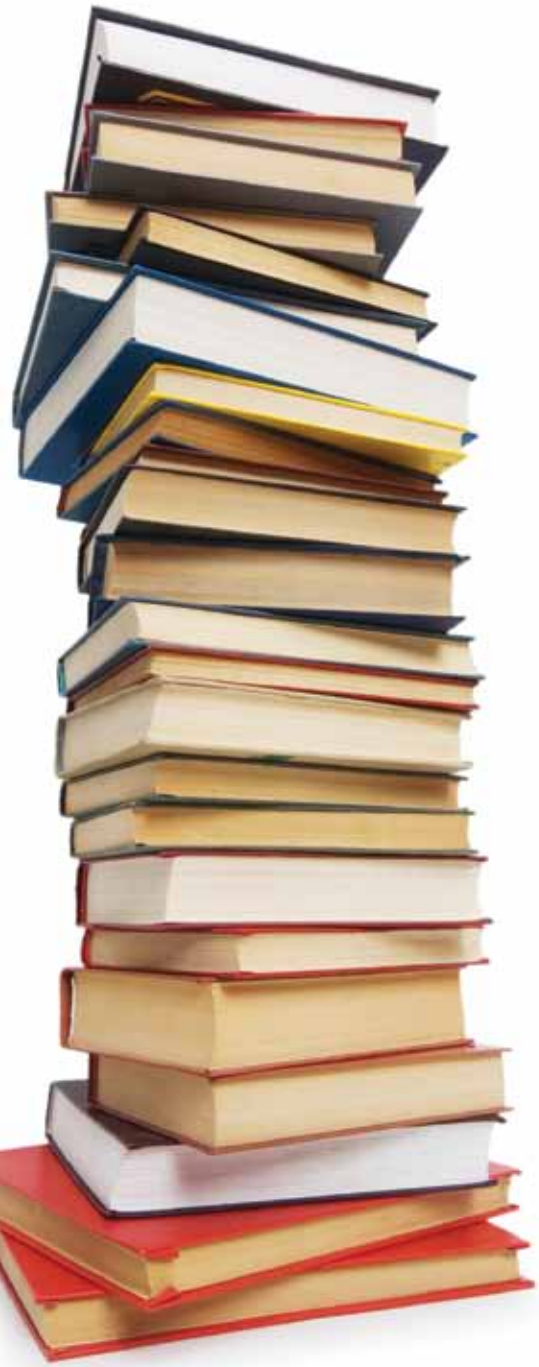
Wolf, K. L. 1998. Trees in business districts: positive effects on consumer behavior! Fact Sheet #5. Seattle: University of Washington, College of Forest Resources, Center for Urban Horticulture. 2 p. Web: www.naturewithin.info/CityBiz/Biz3Ps-FS5.pdf.

Wolf, K. L. 2003. Youth and Mental Health: Work Projects in Urban Green Space. In C. Kollin (ed.), Engineering Green: Proceedings of the 11th National Urban Forest Conference. Washington, DC: American Forests.

Wolf, K. L. 2005a. Business District Streetscapes, Trees and Consumer Response. *Journal of Forestry.* 103 (8): 396-400.

Wolf, K. L. 2005b. Civic Nature: Valuation: Assessments of Human Functioning and Well-Being in Cities. *In:* Forging Solutions: Applying Ecological Economics to Current Problems, Proceedings of the 3rd Biennial Conference of the U.S. Society for Ecological Economics (July 20-23, 2005). Tacoma, WA: Earth Economics.

Wolfe, Mary K. Mennis, Jeremy. 2012. Does vegetation encourage or suppress urban crime? Evidence from Philadelphia, PA. *Landscape and Urban Planning,* Volume 108, Issues 2-4, November-December 2012, Pages 112.122.



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