Green Tukwila 20-Year Stewardship Plan

GREEN TUKWILA
PARTNERSHIP

City of Tukwila

Washington

Resolution No. 1906

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF TUKWILA, WASHINGTON, ADOPTING THE GREEN TUKWILA 20-YEAR PLAN FOR THE CITY OF TUKWILA.

WHEREAS, the City of Tukwila, through the Parks, Recreation and Open Space Plan, has identified the importance and value of: sustaining green and open space in the City, seeking opportunities for land conservation, enhancing the urban tree canopy, and providing more environmental education; and

WHEREAS, the City of Tukwila Parks & Recreation Department desires to partner with the public and local businesses on volunteer stewardship restoration projects within the City that directly benefit those who work, live, and play in the City of Tukwila; and

WHEREAS, City staff and the Park Commission have completed review and modification of the Green Tukwila 20-Year Plan ("the Plan"), and have forwarded the Plan to the City Council for review and adoption; and

WHEREAS, the Plan was created after solicitation and receipt of public input via multiple outreach methods;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF TUKWILA, WASHINGTON, HEREBY RESOLVES AS FOLLOWS:

The Green Tukwila 20-Year Plan, attached hereto as Exhibit A, is hereby adopted.

PASSED BY THE CITY COUNCIL OF THE CITY OF TUKWILA, WASHINGTON, at a Regular Meeting thereof this 6TH day of March, 2017.

ATTEST/AUTHENTICATED:

Christy O'Flaherty

Christy O'Flaherty, MMC, City Clerk

Dennis Robertson

Dennis Robertson, Council President

APPROVED AS TO FORM BY:

Rachel B. Turpin

Rachel B. Turpin, City Attorney

Filed with the City Clerk: 3-1-17
Passed by the City Council: 3-6-17
Resolution Number: 1906

Attachment: Exhibit A – Green Tukwila 20-Year Plan

W:\Word Processing\Resolutions\Adopt Green Tukwila 20-Year Plan 2-7-17
RE:bjs

ACKNOWLEDGMENTS

The Green City Partnerships program started in 2004, comprises a network of public-private ventures between Forterra, local government agencies, businesses, organizations, and citizens. This effort set the stage for engaging the public in ongoing stewardship of urban forests and natural areas and was expanded into cities throughout the Puget Sound Region with the formation of new partnerships. We developed the Green Tukwila Partnership based on these efforts, creating a plan to address the needs of the Tukwila community. This important work was funded, in part, by a generous grant from Boeing's Healthy Communities Initiative.

City of Tukwila Elected Officials

Mayor: Allan Ekberg

City Council: Dennis Robertson, *Council President*
Joe Duffie
Verna Seal
Kathy Hougardy
De'Sean Quinn
Kate Kruller
Thomas McLeod

Park Commission: Mike Martin, *Chair*
Don Scanlon
Sean Albert
Heidi Watters
Matt Mega

Tukwila Staff Advisory Group

Robert Eaton, *Parks and Recreation Manager*
Carol Lumb, *Senior Planner, Department of Community Development*
Andrea Cummins, *Urban Environmentalist, Department of Community Development*
Mike Perfetti, *Habitat Project Manager, Public Works Department*

Forterra

Norah Kates, *Green Cities Project Manager*
Kimberly Frappier, *Restoration Ecologist*
Matt Mega, *Green Cities Project Manager*
Joanna Nelson de Flores, *Green Cities Director*
Nicole Marcotte, *Green Cities Project Associate*
Christopher Walter, *GIS Director*

American Forestry Management, Inc.

Data Collection

Jesse Saunders, *Inventory Forester*

Ted Hitzroth, *GIS Manager*

Illustrations

Andrea Mojzak

Photography

Nicole Marcotte

Georgina Kerr

Photography by McRob (www.mcrobphoto.com)

Billy Hustace (hustacephotogrpahy.com)

Nick Krittawat

Uncredited photos were taken by Forterra or Tukwila Parks and Recreation

Editing

Diane Sepanski

TABLE OF CONTENTS

Acknowledgements 1
Executive Summary 6
I. Introduction 8
The Need for a Green Tukwila Partnership 9
Investing in Tukwila's Urban Forest: Public Health, Economic and Ecosystem Benefits 10
II. The Challenge: Threatened Forests and Natural Areas 15
Tukwila's Parks, Trails and Open Spaces 15
Challenges and Threats to Sustainability 16
Fragmentation 16
Declining Habitat Quality 16
Invasive Species: Plants 17
Invasive Species: Insects 18
Native Vegetation Struggling to Regenerate 19
Illegal Activity 19
Climate Change 19
Resource Limitations on Forest and Natural Area Restoration and Maintenance 20
III. Meeting the Challenge 21
The Mission and Vision 21
Outcomes 22
Goals 22
Partnership Roles and Responsibilities 23
City of Tukwila 23
Seattle City Light 24
King County Parks 24
Tukwila School District 24
Highline School District 24
Washington Department of Transportation 24
Washington Department of Natural Resources 24
Nonprofit Organizations 25
Volunteers and the Community at Large 26
Commercial and Nonprofit Field Crews 26
Funders, Donors and Sponsors 27
Private Landowners 28
IV. Forest and Natural Areas Assessment 29
Methods 29
Tree-iage and Forest Landscape Assessment Tool (FLAT) 29
Tree-iage Categories 30
Results 31
Tree-iage Matrix 31
Overstory Species 32
Regenerating Overstory Species 33

Native Understory Species 33
Invasive Species 33
Slope 35
V. Moving Forward — The Next 20 Years 36
Field 36
Field Objective 1: Prioritize Parks and Natural Open Space Sites 37
Field Objective 2: Prioritize Restoration Work Zones Within Sites 37
Field Objective 3: Identify Areas that Require Professional Crew and Staff Support 38
Field Objective 4: Implement BMP's in Restoration and Stewardship on all Project Sites 38
Best Management Practices 38
The Four-Phase Approach to Restoration Fieldwork 38
Application to the Tree-age Categories 41
Community 46
Community Objective 1: Promote Positive Engagement with Parks and Natural Open Space 46
Community Objective 2: Prioritize Safety and Use Partnership Efforts to Contribute to Public Safety 46
Community Objective 3: Develop and Implement a Community Outreach and Engagement Plan to Equitably Serve Tukwila's Diverse Residential Population 46
Community Objective 4: Work With Local Businesses to Encourage Corporate Support for the Partnership 48
Community Objective 5: Seek Opportunities to Engage Youth and Provide Education 48
Community Objective 6: Build a Steward Program to Promote and Support Community Leadership 48
Community Objective 7: Appreciate Volunteers and Publicly Celebrate Partnership Success 49
Community Objective 8: Engage and Educate Residents and Private Landowners 49
Resources 50
Estimating Program Costs 50
Resource Objective 1: Continue Current City Funding and Build Capacity for Future Growth 55
Resource Objective 2: Leverage City Funds Through Partnerships and Develop Long-Term Funding to Support the Work 55
Resource Objective 3: Provide Sufficient Staff and Resources to Support Fieldwork, Volunteer Outreach and Management, Community Engagement and Program Administration 55
Resource Objective 4: Coordinate Efforts by Partner Staff and Volunteers to Maximize Joint Success and Share Resources 56
Resource Objective 5: Deploy Skilled Field Crews as Appropriate, Prioritizing Training Crews and Job-Skills-Development Programs Available to Tukwila Residents 57
Resource Objective 6: Increase Volunteer Engagement to Leverage Support From Community 57
Resource Objective 7: Support Local Businesses 58
VI. Adaptive Management 59
Measuring Success 60
Program Evaluation 60
Field Monitoring 61
Resource Distribution 61
Reporting and Knowledge Sharing 61
VII. References and Further Reading 63
VIII. Appendices 66
Appendix A: Neighborhood Tree-iage Maps 66

Appendix B: Forest Landscape Assessment Tool (FLAT) Flow Chart for Habitat Composition 74
Appendix C: Management Unit Acres per Tree-iage Acre per Park 75
Appendix D: Dominant Overstory Species by Management Unit Acres 77
Appendix E: Understory Species Dominance by Management Unit Acres 78
Appendix F: Invasive Species Occurrences by Management Unit Acres 79
Appendix G: Public Input 80
Appendix H: Short and Long-Term Strategic Plan and Benchmarks 84
Appendix I: Glossary of Terms 87

LIST OF FIGURES

Figure 1: Green Tukwila Partnership Site Map 14
Figure 2: A Projection of Forest Decline 17
Figure 3: A Projection of Forest Restored 21
Figure 4: Tree-iage Legend 30
Figure 5: Distribution of Management Acres Across Tree-iage Categories 31
Figure 6: Canopy Composition 31
Figure 7: Invasive Cover 32
Figure 8: Distribution of Overstory Tree Species by Management Unit Acres 32
Figure 9: Distribution of Top Five Regenerating Overstory Species by Management Unit Acres 33
Figure 10: Distribution of Top Five Regenerating Overstory Species by Management Unit Acres 34
Figure 11: Distribution of Most Common Invasive Species by Management Unit Acres 34
Figure 12: Decision tree for prioritizing restoration sites 37
Figure 13: Restoration Strategies and Tree-iage Categories 39
Figure 14: 20-Year Projections of Program Costs and Volunteer Match Value 52
Figure 15: Adaptive Framework Cycle 59

LIST OF TABLES

Table 1: Quantity and Value of Air-Quality Services Provided by Tukwila's Urban Forest 11
Table 2: Ecological and Public Health Benefits of Urban Forest and Natural Areas 12
Table 3: Green Tukwila Partnership Management Structure 27
Table 4: Land Ownership (acres) 50
Table 5: Average Restoration Cost per Acr by Tree-iage 51
Table 6: Parks and Recreation Land Cost Summary 52
Table 7: School District Land and ROW Cost Summay 53
Table 8: King County, Washington State Dept of Transportation, Seattle City Light and Private Lands 53
Table 9: Other Jointly Managed Lands Cost Summary 54
Table 10: All lands Cost Summary 54
Table 11: Balanced Scorecard 62

EXECUTIVE SUMMARY

In 2015, the City of Tukwila and Forterra formed a partnership to evaluate the condition of Tukwila's forested parks and natural areas, and develop a plan to help ensure that Tukwila's vision of a sustainable, healthy system of connected parks and natural areas becomes a reality. Tukwila is the eighth Green City, and joins Seattle, Tacoma, Puyallup, Kent, Redmond, Kirkland, Snoqualmie and Everett. Together, Green Cities in the Puget Sound Region located in three counties (King, Pierce and Snohomish), represent a population of more than 1.3 million people with a goal to restore and maintain 9,000 acres of land. The Green Tukwila Partnership will join this robust network of resources and expertise, helping to ensure a livable and healthy region.

Photo by Nick Krittawat

The City of Tukwila undertook the creation of this Green Tukwila 20-Year Stewardship Plan to provide a strategy for the active restoration and management of 138 acres of land. Restoring these lands is considered critical to the health and welfare of the citizens of Tukwila. Although this is an ambitious task, it is important for the health of natural areas and the City of Tukwila, and it is only possible with the help of an engaged community and volunteer leaders. Tukwila's natural areas face the same kinds of pressures and problems as many urban forests, including fragmentation, an invasive-dominated understory that inhibits native species from regenerating, a declining tree canopy, and resource limitations on natural-area management and restoration. These pressures diminish the benefits provided by these valuable lands, such as reduced stormwater runoff, improved water and air quality, attractive communities and stronger property values, greenhouse gas reduction, habitat for native wildlife, and improved quality of life.

The Green Tukwila Partnership's vision is to have healthy forested urban parks supported by an aware and engaged community in which individuals, neighborhoods, non-profits, businesses, and city government all working together to protect and maintain their valuable public resources. The envisioned management program will be dedicated to restoring and maintaining forested parks and natural areas while fostering appreciation and understanding of the long-term benefits that urban forests provide to the City of Tukwila. The intent of this plan is to articulate measurable goals and objectives, develop strategies for achieving these goals and establish benchmarks for evaluating success. This plan will ensure the public investment in these lands is effectively and efficiently allocated across natural areas in Tukwila and that the full implementation of this plan over the 20-year timeframe will be achieved.

The Plan Objectives are:

1. All 138 acres of forested parks and natural areas within the Green Tukwila Partnership will be enrolled in active restoration and maintenance by 2036.
2. An active management program will be in place and will be implemented beyond 2036 to ensure lands in active restoration remain ecologically healthy and provide the numerous ecosystem benefits to the City of Tukwila.
3. A Forest Steward program will be implemented and utilized to engage volunteers to lead restoration efforts of those areas safe and appropriate for volunteer access.
4. A successful volunteer program that engages a diverse community of individuals, families, schools, businesses and non-profits will be in place.
5. Sustainable funding and staff resources to accomplish long-term restoration and management objectives will be secured.

6. A monitoring and adaptive management program will be created and implemented to ensure all lands within Phase 4, long-term maintenance are monitored on a three year rotating basis

To accomplish the goals of this plan an analysis of the 138 acres of land was conducted. The results of the data analysis demonstrate that two significant factors will influence the restoration of forested parks and natural areas in both prioritization and timing. The first is that the majority of lands (90%) are impacted by invasive vegetation. Sites with a high degree of invasive cover will require multiple treatments over the course of many years. This will extend the length of time needed before these sites can enter into Phase 4, the long-term maintenance phase. Secondly, while some sites do have Douglas-fir and western redcedar regeneration, the dominate forest regeneration is black cottonwood, bigleaf maple and red alder. This is significant because it provides an indication of how much planting will be required to restore sites to a healthy condition. Sites with little to no conifer regeneration will require more tree plantings. Sites with older deciduous trees will also need to be monitored for hazard tree conditions and may necessitate expensive tree removal on some sites. Together a site with little natural tree regeneration and high invasive vegetation cover will require extensive restoration, including significant invasive plant removal and installation of native plantings, extending the restoration timeline.

Based on the condition assessment results, this plan establishes a method of prioritizing habitat restoration activities and provides a four phase restoration approach. The four phase approach to restoration starts with invasive plant removal, initial planting of native species, a period of plant establishment and finally long-term monitoring and care. Prioritization will occur based on site conditions, community support, habitat value, geographic distribution and available resources to support restoration.

A cost analysis was conducted for the 20-year timeframe and determined that the total cost will be $5.7 million dollars (2016 dollars) to enroll all 138 acres into active restoration. The cost analysis was also refined to provide an estimate to enroll the 88 acres of land owned and managed by the City of Tukwila Parks and Recreation Department into active restoration. This estimate was $3.5 million. The total cost for the Green Tukwila Partnership is a significant investment, but one that will ensure the long-term sustainability of Tukwila's forested parks and natural areas. This cost also includes volunteer and skilled professional crew coordination and management. Volunteers help ensure long-term success and community ownership. Working side by side with city staff, volunteers are forecasted to leverage up to an additional $2 million in value for the Partnership during the course of the program.

Successful completion of this plan will result in a system of healthy, functioning forested parkland and natural areas for improved ecosystem benefits, such as clean air, climate change mitigation and human mental health.

I. INTRODUCTION

Forests and natural open spaces play a vital role in the environmental, economic, and public health of our cities. Tukwila's parks, trails and open spaces are an invaluable asset for the city and the people who live, work, and play here. When taken care of properly, nature close at hand can make Tukwila's neighborhoods active and vibrant, and help define the community. Tukwila's urban forest, natural shorelines, streams, and wetlands provide numerous services that benefit all areas of the city. They absorb stormwater runoff and stabilize shorelines and steep slopes, thereby reducing flooding and erosion. The vegetation and soils in these forests filter polluted runoff, providing clean water. Air quality is improved through the capture of particulates intercepted by the tree canopy (McPherson, 1994), and by providing shade on the hottest days, which has an effect on many temperature-dependent and/or ozone-forming chemicals (Nowak 2002). The cooling effect created through a combination of shade and altered patterns of air movement are greatest within a forested area, but also extend to developed areas outside of nearby parks. Cooler temperatures make urban areas more comfortable on hot days, but can also have significant impacts on human health, as heat waves cause hundreds of deaths in the United States annually. Vulnerable populations such as the young, elderly, and sick are especially at risk. Natural open spaces also enhance the livability of our neighborhoods, make our city more beautiful, and provide habitat for local wildlife.

Historically, development was the largest threat to natural areas in urban and suburban centers in the Puget Sound region. Public agencies and land trusts have worked to reduce this threat by purchasing and conserving natural areas — land conservation is an important first step in preserving the region's natural resources. Many properties were originally forests set aside to allow nature to take its course with the goal of minimizing human impacts. We have learned, however, that urban environments face unique pressures that render passive management inadequate to maintain a high quality of environmental health. Invasive species, litter, pollution, changes in surrounding land use, and parcel fragmentation reduce the forest's ability to thrive within cities and suburban areas. Urban forest areas are disappearing, and with them go the critical services they provide. Lack of engagement by residents combined with lack of upkeep can lead to public perception of these areas as neglected, uninviting, and dangerous, which is sometimes true.

The dominance of nonnative plant species, such as English ivy, Himalayan and evergreen blackberry, reed canary grass, and Scotch broom, is reported to be a major cause of biodiversity loss and ecosystem degradation in urban forests

What Is Active Management?

Tukwila's parks, trails and open spaces have a variety of needs, some of them specific to urban areas. Meeting these needs and caring for these parks includes removing invasive plants, planting native plants, watering, mulching, stabilizing stream banks, removing garbage or yard waste, maintaining trails, or visiting to check for new problems that arise. We refer to these activities as "active management," which acknowledges that caring for urban natural areas requires a dynamic, hands-on effort in the field to counteract the pressures they face.

(Pimentel et al. 2000; Soule 1991). These invasive weeds lack natural population control (e.g., predators, diseases) and are capable of rapid reproduction; they can quickly blanket the understory and prevent native plants from reseeding (Boersma et al. 2006). Invasive vines such as English ivy and clematis climb into treetops, where they can block light from reaching a tree's leaves, and their heavy weight can topple trees. Without native plants in the understory, habitat and food supply for native wildlife are greatly reduced, and the next generation of native tree canopy is lost. This problem is exacerbated by the fact that a significant portion of forest canopy in the Puget Sound region is now composed of relatively short-lived, mature bigleaf maples and red alders coming to the end of their life spans. As these trees succumb to age, new seedlings are not present to replace them, resulting in a loss of forests over time.

Tukwila's urban forests can significantly benefit from intervention to help reverse this trend and prevent major loss of habitat and ecological functions. The City of Tukwila and Forterra partnered to develop a coordinated restoration and stewardship program called the Green Tukwila Partnership. The Partnership developed this 20-year Stewardship Plan to comprehensively assess the conditions of Tukwila's forested parkland and natural open space under the jurisdiction of the city and several partner land-owning agencies. The plan also assesses agency coordination and capacity, promotes community participation, and establishes the long-term planning needed to support the Partnership's goals and vision.

THE NEED FOR A GREEN TUKWILA PARTNERSHIP

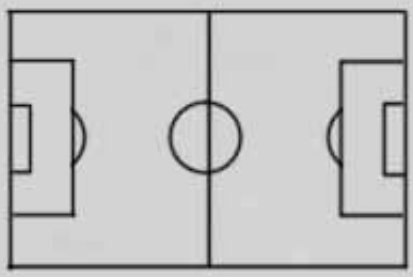
With continued population growth anticipated throughout the Puget Sound region, Tukwila's residential and business density will be higher. One of the challenges facing the city is how to balance this growth while maintaining a strong economy and exceptional quality of life. For example, since increasing high-density housing, including condominiums and multifamily developments, often results in less personal access to open space and the natural environment, it is important to protect and enhance Tukwila's parks and natural areas.

Additionally, urban developments such as condominiums, townhouses, and office parks are considered more desirable when they are conveniently located and accessible by bike or on foot, near transit, parks, and natural areas (Tyrväinen and Miettinen 2000). This measurable value is due to the fact that green space is an important element of livable, attractive communities. Parks, trails, and natural areas give people who live in cities recreational opportunities and a connection to nature that can help sustain a vibrant urban life. Trees and green space are also associated with a variety of measurable public health benefits by providing people with access to nature and the amenities needed for exercise, both of which have links to stress reduction and physical wellness (see Table 2).

In 2005, Forterra launched the Cascade Agenda, a 100-year vision for conservation and economic growth in the Pacific Northwest, with a central focus on building livable urban communities. Recognizing that access to healthy parks is a key component to a livable city, the City of Tukwila is com-

How Large is 138 Acres?

At 138 acres, Tukwila's forested parks and natural areas, combined together, represent and area that is 73 times the size of a regulation soccer field or 2.5 times the size of Fort Dent.



Soccer Field x 73

Fort
Dent x 2.5

mitted to providing access and care to their valuable natural areas. Combined, Tukwila's parks and natural open space make up 138 acres, roughly 2% of the City's total land area. The Partnership aims to bring 138 acres of Tukwila's forested parkland into active management over the next 20 years. Although this is an ambitious task, it is crucial for the health of the city's urban forests — and the city itself. This will only be possible with the help of an engaged and dedicated community that has an ownership stake in the Green Tukwila Partnership's success.

Similar Green City Partnerships have already seen success in Seattle, Tacoma, Kirkland, Redmond, Kent, Everett, and Puyallup. Together, these partnerships are establishing one of the largest urban-forest restoration programs in the nation.

INVESTING IN TUKWILA'S PARKS, TRAILS AND OPEN SPACE: PUBLIC HEALTH, ECONOMIC, AND ECOSYSTEM BENEFITS

The benefits of caring for Tukwila's urban forests affect many aspects of the community. Research indicates that urban forests give people a higher quality of life (Dwyer et al. 1992), provide ecosystem functions, and create opportunities to improve physical and mental health, and enjoy nature close at hand. They help keep the air and water cleaner, provide habitat for native wildlife, and make communities more livable and beautiful.

The Puget Sound region's forests provide measurable, valuable services that affect us every day. In 1998, American Forests, a nonprofit citizens' conservation organization, analyzed our urban forests. Its study revealed that these trees removed 38,990 tons of air pollution — a service that was then valued at $166.5 million. The study also showed that the trees created a 2.9 billion-cubic-foot reduction in runoff, a service valued at $5.9 billion (American Forests 1998). Were these forests to be lost, these dollar values become the costs associated with building new infrastructure to carry out equivalent functions.

A city with abundant and healthy vegetation enjoys significantly higher air quality. Conifers, specifically, can remove 50 pounds of particulate pollutants from the air per year (Dwyer et al. 1992), which is correlated in studies with a reduced incidence of asthma in children and other related respiratory health issues in people of all ages (Logvasi et al. 2008).

Urban forests also help combat climate change and the effects of air pollution. Trees, as they grow, capture carbon dioxide through the process of photosynthesis and help remove soot and other pollutants through their leaves and branches. They store the carbon from the absorbed carbon dioxide in the woody mass of their branches and trunks, and release oxygen into the air. It is estimated that Washington State's urban trees are responsible for the sequestration of more than 500,000 tons of carbon per year (Nowak and Crane 2001). Each acre of healthy, mature Western Washington forest could be responsible for the storage of more than 300 tons of carbon, which translates to the removal of more than 1,100 tons of carbon dioxide from the atmosphere (Smithwick et al. 2002). For example, the average passenger vehicle emits 4.7 tons of carbon dioxide per year (EPA 2014). This means each acre of healthy forest removes carbon dioxide emissions for approximately 234 vehicles.

Trees in an urban setting combat the "urban heat-island effect" caused by paved surfaces absorbing and radiating heat from the sun. Trees produce shade, reflect sunlight well above the pavement, and convert sunlight through photosynthesis. Urban forests also create microclimates that move air and further cool their surroundings. They have been shown to significantly lower ambient temperatures, making hot days more comfortable and reducing energy consumption needed for artificial cooling (Nowak and Crane 2001). A single 25-foot tree reduces a typical residence's annual heating and cooling costs by an average of 8%–12% (University of Washington Center for Urban Horticulture 1998).

While invasive plants such as ivy and blackberry also carry out photosynthesis to sequester carbon and create oxygen, they are shorter lived and contain less biomass than mature conifers. This makes them less effective at removing carbon dioxide from the atmosphere and storing it. Additionally, they often do not supply adequate habitat for local native wildlife and are much less effective at providing other ecosystem functions than healthy native Northwest forest communities. For example, while some birds will nest in blackberry bushes, it takes a variety of native plants to provide nesting opportunities for all our local bird species (Marzluff 2000). The monocultures that invasive plants typically create do not foster the diverse assemblage of interrelating native species that keep natural areas healthy and stable.

In 2012, Davey Resource Group estimated the benefit of trees to the City of Tukwila as part of a tree-canopy assessment. Table 1 shows the approximate quantity of pollutants intercepted and the value of that service to the city. These values were generated using i-Tree VUE and are referenced in the City of Tukwila Comprehensive Plan 2015.

More research is still needed to quantify the economic and ecosystem functions provided by urban forests specific to the City of Tukwila. Additionally, drawing from the wide body of knowledge and related studies outlined here, we know that the cost of doing nothing to maintain the health of our public natural areas could be high and have negative effects on the city's environmental, economic, and public health. As development throughout the region continues at a rapid pace, our remaining parks and natural areas are more important than ever.

Pollution Source	Approximate Benefit	Approximate Value
Stored carbon	71,000 tons	$1.4 million
Sequestered carbon	2,300 tons/year	$48,000
Carbon monoxide	4.3 tons/year	$4,000
Nitrogen dioxide	10 tons/year	$89,000
Ozone	4.3 tons/year	$240,000
Sulfur dioxide	8.5 tons/year	$18,000
Particulate matter	15.7 tons/year	$94,000
Yearly benefit		*$1.9 million*

Table 1: Quantity and value of air-quality services provided by Tukwila's urban forest

Table 2: Ecological and public health benefits of urban forests and natural areas

REDUCE STORMWATER RUNOFF	Tree canopies reduce the rate at which rain falls to the earth. Water enters the ground more slowly under trees and is better absorbed and filtered into groundwater than when it runs off paved and nonporous surfaces. Since conifers and other evergreen plants grow year-round, more water moves up from the ground, through plant tissues, and into the atmosphere as water vapor. Urban forests can reduce annual stormwater runoff by 2%-7%, and a mature tree can store 50-100 gallons of water during large storms (Fazio 2012). Green streets, rain barrels, and tree planting are estimated to be 3-6 times more effective in managing stormwater per $1,000 invested than conventional methods (Foster et al. 2011).
IMPROVE WATER QUALITY	Plant roots absorb water, much of which is full of pollutants in an urban environment. Some pollutants are filtered and transformed by bacteria and other microorganisms in the soil (Prince George's County 2007); others are transformed by plants through metabolism or trapped in woody tissues and released when a tree decomposes. Forested buffers around streams have been shown to reduce sediment and nutrient pollution levels (Osborne and Kovacic 1993).
REDUCE EROSION	As the tree canopy slows the speed of rain falling on the earth, rainwater has less energy to displace soil particles. Soils under a canopy and the thick layer of leaf litter are protected from the erosive energy of rainwater (Xiao et al. 1998).
IMPROVE AIR QUALITY	Plant leaves absorb carbon dioxide and produce oxygen through photosynthesis. The surfaces of leaves trap airborne dust and soot (McPherson et al. 1994), removing millions of pounds of air pollutants annually from the air in a city (American Forests 2001).
PROVIDE WILDLIFE HABITAT	Native wildlife has unique requirements for food and shelter. Although raccoons and crows adapt well to urban environments, many native species do not. They require a variety of plants and multiple layers of canopy to forage and nest. Healthy urban forests under restoration have been demonstrated to increase species diversity (Ruiz-Jaén and Aide 2006).
REDUCE ENERGY USE & COMBAT CLIMATE CHANGE	A 25-foot tree reduces annual heating and cooling costs of a typical residence by an average of 8%-12% (University of Washington 1998). Trees absorb carbon dioxide and store the carbon in woody tissues, reducing the amount of carbon dioxide in the atmosphere. Urban forests have the capacity to lower energy consumption in urban environments by lowering ambient temperatures and to create microclimates conducive to air movement. Lowering energy consumption reduces electricity use and the amount of carbon dioxide emitted into the atmosphere from power plants (Nowak and Crane 2001). Each year, an acre of trees absorbs the amount of carbon produced by driving a car for 26,000 miles (Nowak et al. 2002).
BOOST LOCAL & REGIONAL ECONOMY	Urban forestry supports job creation and retention, resulting in added individual income and increased local, state, and federal taxes (CalFire 2011). Homes that border urban forests may be valued at up to 5% more than comparable homes farther from parks (Tyrväinen and Miettiner 2000), and street trees add value to homes as well (Donovan and Butry 2010). Forested parklands provide residential properties with an adjacent natural area for walking and passive recreation activities such as bird-watching.

Table 2: Ecological and public health benefits of urban forests and natural areas (continued)

BUFFER NOISE

Tree canopies dampen sound by intercepting sound waves (Herrington 1974). Noise buffers composed of trees and shrubs can reduce 50% of noise detectable by the human ear (USDA 1998), including high-frequency noise, which is most distressing to people (McPherson et al. 2001).

COMMUNITY BUILDING

Physical features, particularly nature, play an important role in creating vital neighborhood spaces (Sullivan et al. 2004). Urban greenspaces and parks provide a gathering place for people of different backgrounds to connect with each other. Strong community relationships are built from exchanging information and working together to achieve common goals (e.g., open-space improvements). Residents who are more attached to their community have higher levels of social cohesion and social control, less fear of crime, and display more signs of physical revitalization of the neighborhood (Brown et al. 2003).

MAKE COMMUNITIES MORE ATTRACTIVE

Vegetation provides visual relief from the built environment. Trees and stretches of parkland can soften the angular edges of buildings, while the natural tones of bark and foliage are easy on the eyes. Trees are known to be the most important factor in influencing the perception of a community's aesthetic value (Schroeder 1989). Trees and natural landscapes are associated with reduced aggression and violence (Kuo and Sullivan 2001), graffiti, vandalism, and littering (Brunson 1999).

PHYSICAL WELLNESS & FITNESS

Physical exercise and activity has been shown to reduce the risk of hypertension, coronary heart disease, stroke, diabetes, and breast and colon cancer (World Health Organization 2010). People who use parks and open spaces are three times more likely to achieve recommended levels of physical activity than nonusers (Giles-Corti et al. 2005). People in communities with high levels of greenery or greenspace are more likely to be physically active, and less likely to be overweight or obese (Maas et al. 2006 and Ellaway et al. 2005).

MENTAL HEALTH& FUNCTION

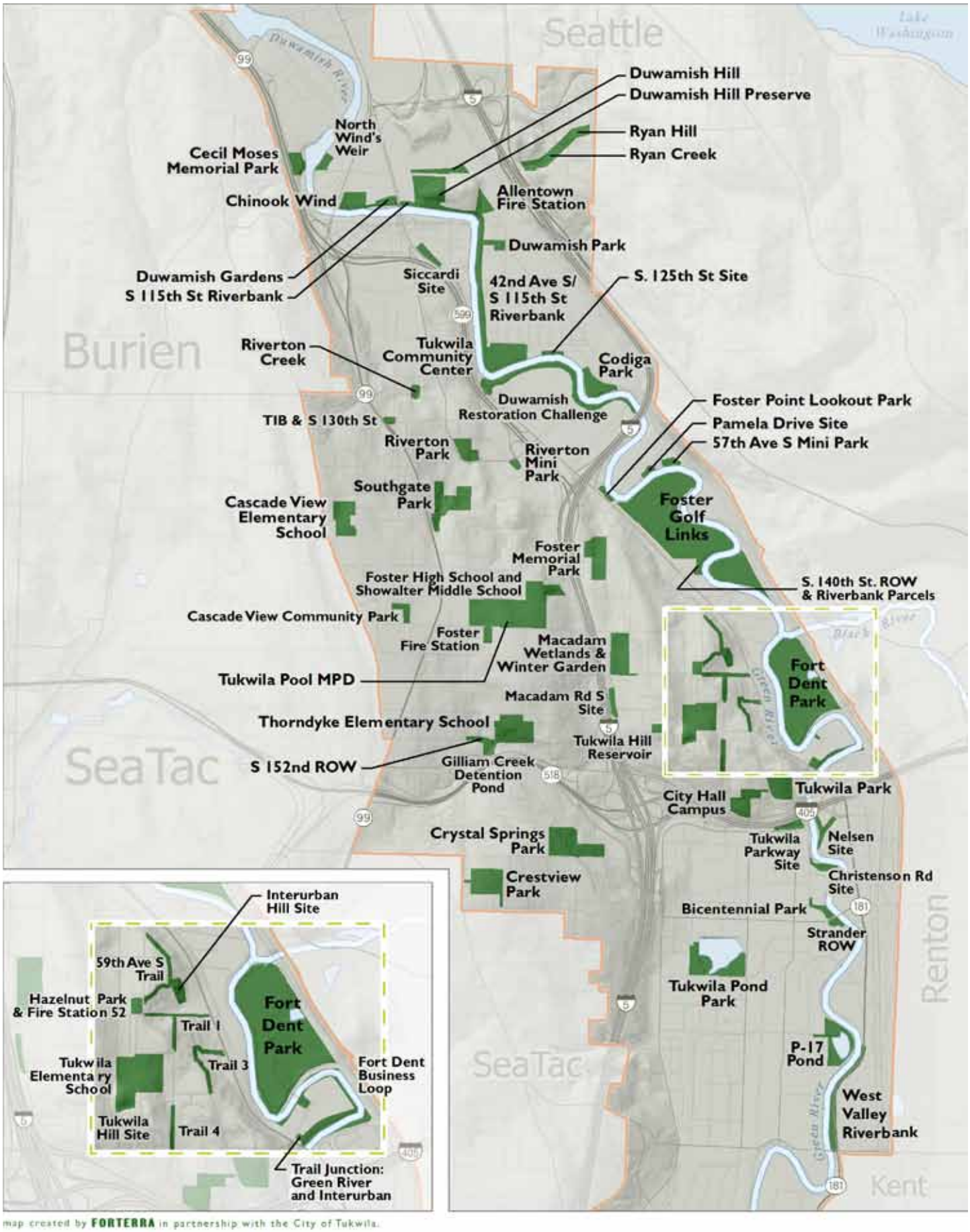
Physical activity has also been linked to decreases in symptoms of stress and depression (U.S. Dept. of Health 1999). The opportunities to exercise provided by trails through forested parks and natural areas is therefore relevant to the treatment of these mental health ailments. Even basic mental function is improved, as the experience of nature helps restore the mind after the mental fatigue of work or studies, improving productivity and creativity (Kaplan 1995 and Hartig et al. 1991).

CHILD DEVELOPMENT

Experience with nature helps children to develop cognitively, emotionally, and behaviorally by connecting them to environments that encourage imagination, cognitive and intellectual development, and social relationships (Isenberg and Quisenberry 2002 and Heerwagen and Orians 2002). Green settings and green play areas also decrease the severity of attention deficit in children (Taylor et al. 2001).

HEALTH BENEFITS OF STEWARDSHIP ACTIVITIES

Volunteer stewards of all ages who regularly remove invasive species, plant trees, and perform other stewardship activities are likely to gain health benefits from physical exertion. In one hour, a 150-lb person can burn 340 calories from digging, gardening, and mulching; 306 calories from planting trees; and 292 calories from raking leaves (www.calorie-count.com).



map created by FORTERRA in partnership with the City of Tukwila.

Figure 1: Green Tukwila Partnership site map

II. THE CHALLENGE: THREATENED FORESTS AND NATURAL AREAS

TUKWILA'S PARKS, TRAILS AND OPEN SPACES

The City of Tukwila is located within the Green-Duwamish River Watershed Water Resource Inventory Area 9, (WRIA 9), split roughly in half between the Duwamish Estuary Subwatershed in the north and the Lower Green River Subwatershed in the south. Land use in the city is a mix of commercial, industrial, and low- and high-density residential. Weaving through this mosaic is 138 acres of forests, wetlands, streams, shorelines, and buffers, managed by the agencies that make up the Green Tukwila Partnership: the City of Tukwila, along with Seattle City Light, Washington State Department of Transportation, King County Parks, Tukwila and Highline School Districts, Washington State Department of Natural Resources. Most of this is publicly owned, and a small amount is private land along the Duwamish River and in public rights-of-way. From the aptly named 57th Avenue S Mini Park, less than a quarter acre in total, to the 11 acres of mature deciduous trees battling invasive ivy in Southgate Park, the city's natural areas range in size, access, composition, and health. Many sites lie along the Duwamish River and provide opportunities to collaborate with larger efforts to help care for this landmark waterway. Sites on school properties offer excellent spaces for outdoor learning and youth engagement. Sites in the city's residential areas are places where neighbors can come together, and sites bordering industrial areas and business parks can engage Tukwila's business community. All together, they have the potential to provide much-needed spaces for outdoor recreation and natural ecological processes within a highly developed landscape.

For the purposes of this plan, forests are defined as the portions of parklands with forested plant communities that have greater than 25% tree canopy and are not mowed or ornamentally landscaped. The plan also encompasses natural areas with less than 25% tree canopy — from riparian and wetland

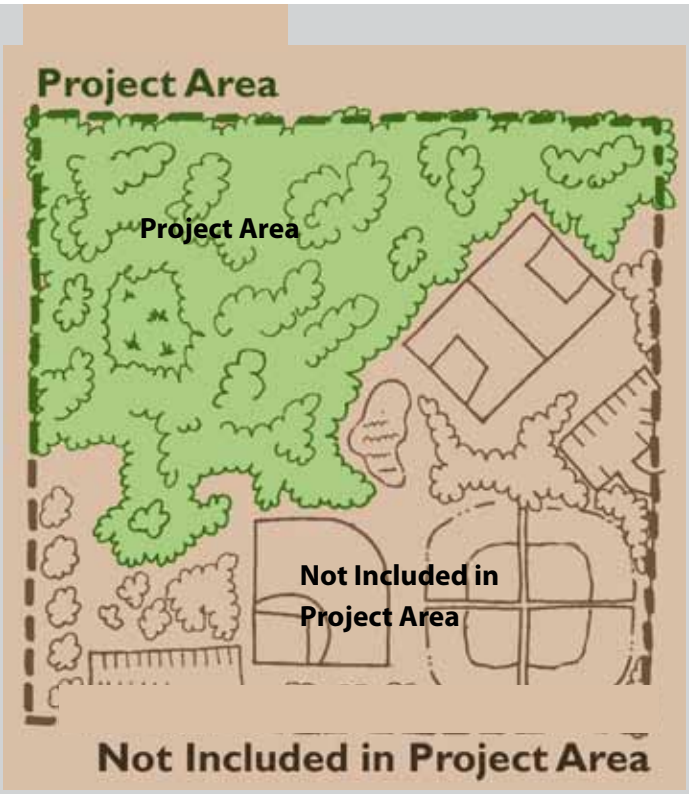
Defining the Project Area

Included in the Green Tukwila Partnership area:

- Forests
- Meadows
- Wetlands
- Streams
- Shorelines
- Buffers
- Future restoration sites intended to grow into one of the above

NOT included in the Green Tukwila Partnership area:

- Ballfields
- Playgrounds
- Beaches
- Orchards
- Landscaped gardens
- Lawns and open fields
- Mowed stormwater detention ponds
- Hardscaped areas like parking lots and paved sport courts



buffers dominated by woody shrubs to forest edges dominated by invasive species, and highly disturbed sites intended for future restoration. Open water, such as in Tukwila Pond Park and the Green-Duwamish River itself, is not included in the Partnership's scope of work.

CHALLENGES AND THREATS TO SUSTAINABILITY

Forests and natural areas in urban settings face unique challenges and pressures that require specific attention. The following section outlines six primary issues that prevent forested and natural-area parklands from sustaining themselves or pose risks to current and future ecological sustainability:

- Fragmentation
- Declining habitat quality
- Invasive species
- Native vegetation struggling to regenerate
- Illegal activity
- Climate change

Fragmentation

Habitat fragmentation is a problem common to urban environments and occurs when contiguous open spaces are divided, often by development, landscaping, sports fields, and roads. This decreases valuable internal habitat areas and increases "edge effects" along the exterior, thereby increasing the habitat's exposure to human impacts. Edge effects refer to the transition between two different habitat types and its effects on the plant and animal communities in the remaining isolated open space. A greater proportion of edge increases a forest's or wetland's susceptibility to encroachment by invasive plants from adjacent landscaped areas and the likelihood of water-quality issues due to polluted runoff (Brabec et al. 2000). Habitats for birds, amphibians, and mammals become isolated from each other with the loss of connectivity through greenbelts or connecting corridors. Because of this unique pressure on forest and natural areas in urbanized environments, restoration and maintenance of these areas are distinct from that of large swaths of rural forests, for example, and require continuous vigilance against the spread of invasive plants and other edge effects.

Declining Habitat Quality

Several factors contribute to the loss of habitat quality in Tukwila's forests and natural areas. Compared with the region's native forest composition, deciduous trees make up much more of Tukwila's forest canopy than is typical in a healthy Northwest forest. These early-colonizing species help establish a forest in disturbed areas, such as after the logging activity that occurred throughout the Puget Sound in the late 1800s to early 1900s, and again in the mid-1900s. Deciduous bigleaf maples, cottonwoods, and alders now dominate the majority of Tukwila's forest overstory. Under natural conditions, as deciduous trees begin to die off, they are typically replaced by longer-lived conifers; however, Tukwila's forests and natural areas no longer grow under natural conditions.

The high proportion of deciduous trees in Tukwila's upland forests indicates that there will be a pronounced decline in tree canopy in the near future. In many areas, the conifer seed bank has been lost through past logging and development. Many of the deciduous trees — both native and nonnative — are nearing the end of their natural life spans. As they die, more sunlight is allowed to reach the ground, resulting in perfect growing conditions for aggressive invasive plants to flourish. The loss of tree canopy allows invasive plants to become the dominant species in many parts of Tukwila's natural areas, inhibiting the new growth of native trees and understory. Without intervention to help ensure that enough young native trees are present in the understory to make up the next generation of canopy, this plan's technical analysis projects that the natural death of these deciduous trees could lead to a loss of much of Tukwila's forest overstory (Figure 2).

Additionally, past removal of vegetation, urban development, and channelization along the Duwamish River and Tukwila's many streams and wetlands resulted in a loss of native species cover. Large stretches of the Duwamish River shoreline, as well as smaller creeks, wetlands, and other sensitive areas, are now buried under a blanket of invasive species such as Himalayan blackberry, English ivy, and Bohemian knotweed. The loss of native vegetation along waterways results in significant impacts on stream temperatures and water quality, and negatively affects aquatic species, including threatened salmon.

Invasive Species: Plants

Invasive plants now outcompete native understory plants in many of Tukwila's forests and natural areas. Aggressive, non-native shrubs and vines cover the ground, blocking sunlight from, and competing for nutrients with, native species. Robust Himalayan and evergreen blackberry bushes spread along the ground in large thickets, and birds disperse the seeds to new locations. Invasive blackberry grows densely, choking out native plants and destroying native habitat for wildlife species. Blackberry thickets are especially aggressive when establishing along creeks and gulches, including the Green-Duwamish River shoreline. Himalayan blackberry is the dominant invasive plant in Tukwila's natural areas: the primary invasive species found in 39% of the Partnership's project area, and present (as either the primary, secondary, or tertiary invasive species) in 88% of the project area. English ivy is the primary invasive species in 38% of the Partnership's project area, and reed canary grass is the primary invasive species in 22%. One or more of these three species is found in almost every site, and a small number of other aggressive invasive species round out the full picture of the threat facing Tukwila's struggling natural areas (see Figure 11, page 34).

English ivy can kill a healthy deciduous tree within 20 years by spreading up from the understory into the tree canopy. Ivy can easily spread from neighboring residential landscapes into nearby parks, where it will become a serious problem, as experienced by many other cities throughout the region. Once ivy becomes established, an intense investment of time and resources is required to remove it. Where English ivy is in the early stages of blanketing forest floors and trees in Tukwila, the opportunity exists to remove the existing growth and prevent further spread and a much bigger future cost of

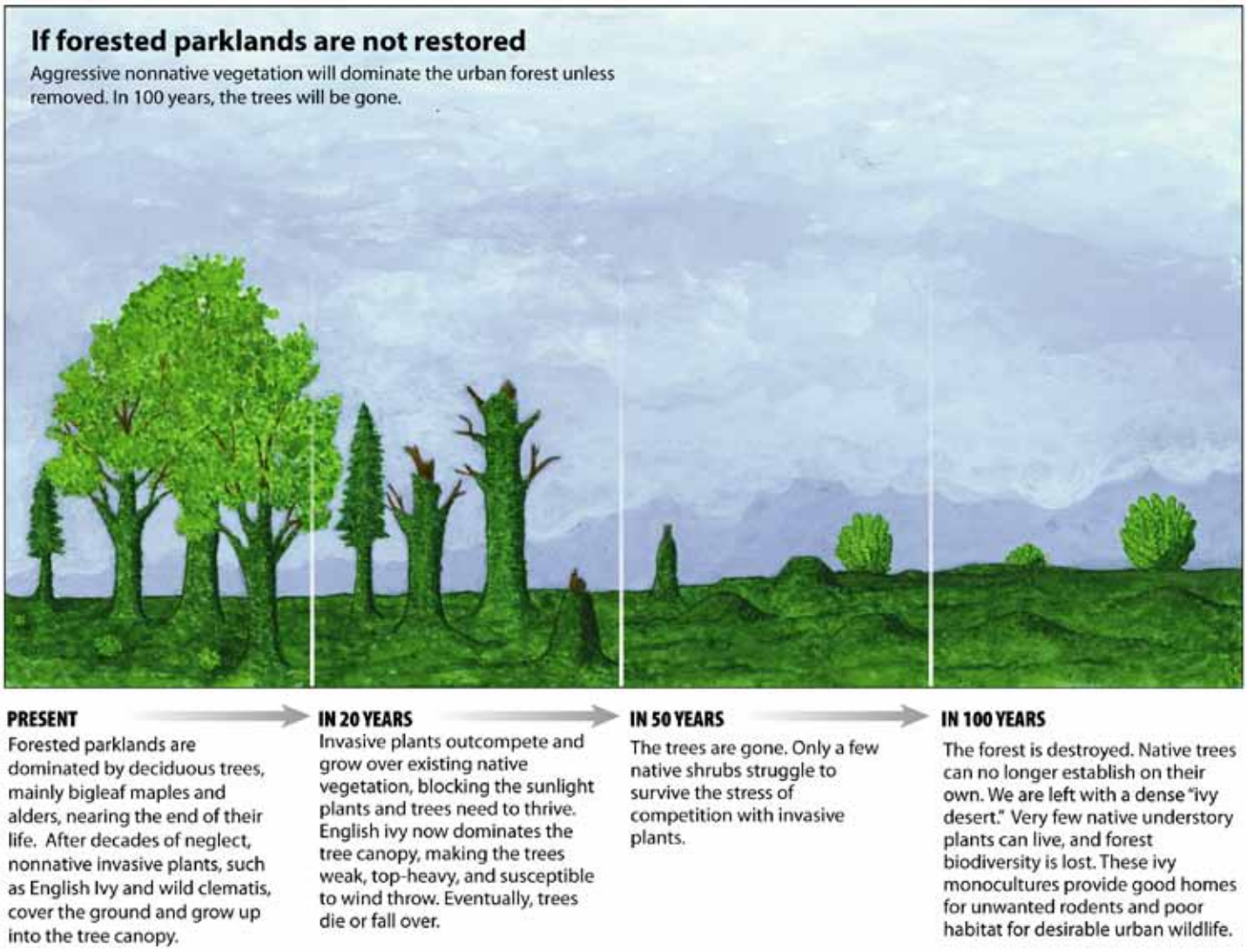


Figure 2: A projection of forest decline

management.

The native understory is an important food source for native Pacific Northwest wildlife and provides much-needed cover and shelter from predators and the elements. In addition to Himalayan blackberry and ivy, other invasive species, such as reed canary grass, Scotch broom, English holly, and morning glory, grow in the understory, crowding out ferns, shrubs, and other native plants. As invasive species begin to dominate the understory, the diversity of food and habitat available throughout the seasons is diminished. While some animals, such as rats, can live and even thrive in the dense monocultures of blackberry or ivy, quality habitat for most native wildlife is degraded by invasive species.

Blankets of Himalayan blackberry on stream banks displace native riparian vegetation. Lack of riparian tree cover also decreases shade along creeks, causing water temperature to rise, which reduces the amount of dissolved oxygen that the water can contain. These altered conditions impair water quality and overall suitability of salmon habitat in the Green-Duwamish River and the streams that make up Tukwila's watersheds.

In addition, environmental benefits such as stormwater retention, erosion control, and carbon sequestration are greatly decreased when invasive species displace complex communities of native vegetation that have grown together throughout this region's history. If the spread of invasive species is not prevented, the result is degraded forests and natural areas overrun with sprawling thickets of blackberry and engulfed in ivy.

Invasive Species: Insects

Native insect activity is a natural part of a healthy forest ecosystem. In fact, insects such as the native Douglas-fir beetle are a needed food source for wildlife and continue natural ecological processes. However, even small infestations of exotic, invasive insects, in the context of the small, fragmented, and oftentimes stressed forest stands that we find in our urban environments, can negatively impact the sustainability and resilience of Tukwila's trees and forests.

Exotic, invasive insects can have catastrophic effects on a region's natural resources and do not contribute to the natural ecological processes found in healthy natural open spaces. For example, states from Michigan to Colorado have seen urban and rural forests decimated by the emerald ash borer. This wood-boring insect targets ash trees, a deciduous hardwood species. First documented in Michigan in 2002, borers have now killed millions of ash trees in 22 US states and two Canadian provinces (Herms et al. 2014). They also pose a threat to the native Oregon ash (Fraxinus latifolia) — a significant component of riparian vegetation in Puget Sound lowlands — present in Tukwila's Macadam Road South Site.

Another wood-borer, the citrus longhorned beetle (Anoplophora chinensis) — a species native to Southeast Asia — was documented in a Washington State nursery in 2001 and 1,000 trees were removed from an area infected in Tukwila (Boersma et al. 2006). Although the eradication was successful and a population of these beetles does not yet exist in our region, Tukwila and its surrounding areas still face the risk of introduction. Wood-boring beetles have been documented in the northeastern US and California since 1996. The Asian long-horned beetle (Anoplophora glabripennis) and the citrus long-horned beetle, which arrive on wood pallets from Asia, are known to attack and kill maple trees and other deciduous hardwoods (Haack et al. 2010).

Outbreaks of Asian and European gypsy moths have also been documented in the Pacific Northwest, though successful control efforts have prevented populations from establishing. In areas where full populations have established, such as in the Northeastern and Midwestern United States, gypsy moths — which forage by defoliating trees— have weakened trees and degraded wildlife habitat on millions of forested acres. Weakened trees then succumb to other pests or disease. In the Pacific Northwest, gypsy moths have been known to attack red alder, Douglas-fir, and western hemlock (Boersma et al. 2006).

To protect Tukwila's forests and natural areas, the Green Tukwila Partnership will need to stay abreast of potential invasive insect outbreaks in the region. Information is available to staff and volunteers through the Washington Invasive Species Council and US Department of Agriculture (USDA) Animal and Plant Health Inspection Service. The Green Cities program, with funding from the USDA Forest Service, has developed a monitoring protocol for Asian long-horned beetle species. This monitoring protocol is specifically designed for citizen scientists and volunteers to assist in detection and could be offered as training for Green Tukwila forest Stewards.

As the Green Tukwila Partnership implements its 20-year plan, insect pests and other forest-health threats should be monitored at each restoration site as part of a detailed park stewardship plan.

To protect urban forests and natural areas from devastating future pest and disease outbreaks, it is absolutely vital that a diversity of native trees and shrubs is planted at all restoration sites. A landscape dominated by just one or a few species is more vulnerable, as most pests and tree diseases attack only certain species. A diverse landscape of different plant species will be more resilient to all kinds of future uncertainties.

Native Vegetation Struggling to Regenerate

Native-tree-canopy regeneration — especially of conifers — is greatly limited in Tukwila's forest and natural areas for several reasons. The landscape-scale loss of native conifer trees due to residential and commercial development has reduced the seed bank for these trees. At the same time, invasive plants have reduced native-tree regeneration by outcompeting or smothering those tree seedlings that do grow. Removal of nonnative invasive plants and planting native trees, shrubs, and ground cover can help the process of native-tree regeneration move forward. This is critical to ensure the future vitality of the city's urban tree canopy and natural areas, and the many ecosystem and human health benefits they provide.

Illegal Activity

In addition to the indirect effects of human development, illegal activity has had a direct impact on urban forest and natural areas as well. Trees are damaged and cut for views or firewood, or in acts of vandalism. Dumped garbage and yard waste is a common problem in parks and natural areas throughout the city. Yard waste forms a layer of debris that smothers and kills native vegetation and contributes to slope instability as it becomes water saturated and heavy. Invasive plants from private yards can escape from dumped piles and spread throughout parks. Garbage can leach chemicals into the ground, attract rodents or other pests, and smother understory vegetation. Encroachments onto public land from adjoining private property and encampments bring with them any number of problems for natural areas, including removal of native habitat for the establishment of ornamental landscaping, lawns, personal views, access paths, built structures, and domestic animals.

While addressing all types of illegal activity will require sensitivity, the issue of homeless encampments is undoubtedly among the most complex. The Partnership will approach encampments on project-area sites with sensitivity toward all involved, and work with social services organizations whenever possible to come up with plans of action in the combined best interest of people experiencing homelessness, neighbors, volunteers, and the parks and natural areas themselves.

Additionally, the sanctuary from built environments that forests and natural areas — especially areas without visible management activity — provide can be a refuge for illegal activity, such as drug use and violent crime. This is an unfortunate reality of open-space management that challenges many communities, especially in an urban setting. When enough illegal activity takes place, forest and natural areas can become known more for the illegal pursuits they harbor than for the valuable benefits they provide. Reversing this perception takes a concerted effort to bring more attention and activity in general to such areas. Problems often arise when people think of undeveloped parks as "empty" or "abandoned" property.

However, as an important aspect of responsibly caring for Tukwila's parklands, and for public spaces in general, addressing illegal activity provides significant opportunities for community engagement. Restoration projects led by the community help reclaim such areas as positive public spaces for everyone by regularly bringing more watchful attention to an area and increasing a sense of public ownership and responsibility. The city also has policies and procedures in place to ensure the safety of park visitors and volunteers. Expanding public awareness and continuing to build a robust Steward program that has high ownership and valuation of forests and natural areas are therefore two main tenets of the Green Tukwila Partnership.

Climate Change

The Pacific Northwest region faces climate-change impacts that include warmer winters; hotter, drier summers; and changes in precipitation (Littell et al. 2009). Climate change is expected to negatively impact the health and resilience of forests and natural areas by shifting the habitat conditions of

native tree species that are common in Puget Sound lowland forests (Kim et al. 2012). Shifts in growing conditions, such as changes to summer and winter temperatures and soil moisture, can directly affect tree health and vigor, and make trees more susceptible to mechanical or physical failure, insect infestations, and disease (Littell et al. 2010).

Conservation and restoration of urban forests and natural areas therefore become increasingly important in addressing these changes by reducing urban heat-island effects, sequestering carbon, and mitigating stormwater impacts from increased precipitation. The Green Tukwila Partnership's restoration efforts are essential to preserve forest and natural area health, and ensure the critical ecosystem functions these resources provide. To improve the ability of forests and natural areas to mitigate as well as adapt to climate-change stressors, Green Tukwila Partnership managers will need to integrate adaptation and resilience strategies into their general management practices and site-level stewardship plans.

Resource Limitations on Forest and Natural Area Restoration and Maintenance

Historically, resources for natural area restoration and maintenance have been limited. The idea that forests and natural areas in urban environments could take care of themselves tended to discourage allocating sufficient funds for planting native species or removing invasive plants. Many forest and natural areas across the Northwest were left to benign neglect under the assumption that they were self-sustaining and without the understanding that they were susceptible to changing conditions and outside influence. This passive management has directly led to declining health in unsupported urban forests and other natural areas. Unfortunately, but unsurprisingly, the longer active management is postponed, the more expensive it becomes, as existing tree canopy declines, invasive species spread prolifically, and threats compound.

To reverse this trend, this plan recommends additional investment in the active management of forested parklands and natural areas. Natural succession cannot occur without a conifer seed base and healthy understory, both of which are currently missing or greatly impaired. Trees are now recognized as city and community assets — or infrastructure — and need to be maintained as such with attendant planning and budgeting. Unfortunately, the level of need exceeds current staffing and funding. By continuing to engage the community in a more structured effort to manage forested parkland, this plan seeks to leverage additional partner investment and volunteer engagement to target this need.

III. MEETING THE CHALLENGE

MISSION AND VISION

The Green Tukwila Partnership's mission is to engage the community in caring for healthy forested parks and natural open space in the city, protecting Tukwila's valuable natural resources for current and future generations to enjoy.

The Partnership will be a collaborative effort bringing together Forterra, the City of Tukwila, Tukwila and Highline School Districts, Seattle City Light, Washington State Department of Natural Resources, King County Parks, Washington State Department of Transportation, and private landowners, as well as other government agencies, nonprofit organizations, educational institutions, local businesses, and the Tukwila community at large. The Partnership's vision is a city with healthy forested parks and natural open space, and an engaged community invested in its urban environment. Sustainable natural areas, specifically forests, will contain a multi-aged canopy of trees, where invasive plants pose a low threat, and a forest floor with a diverse assemblage of native plants that provide a multitude of benefits (Figure 3).

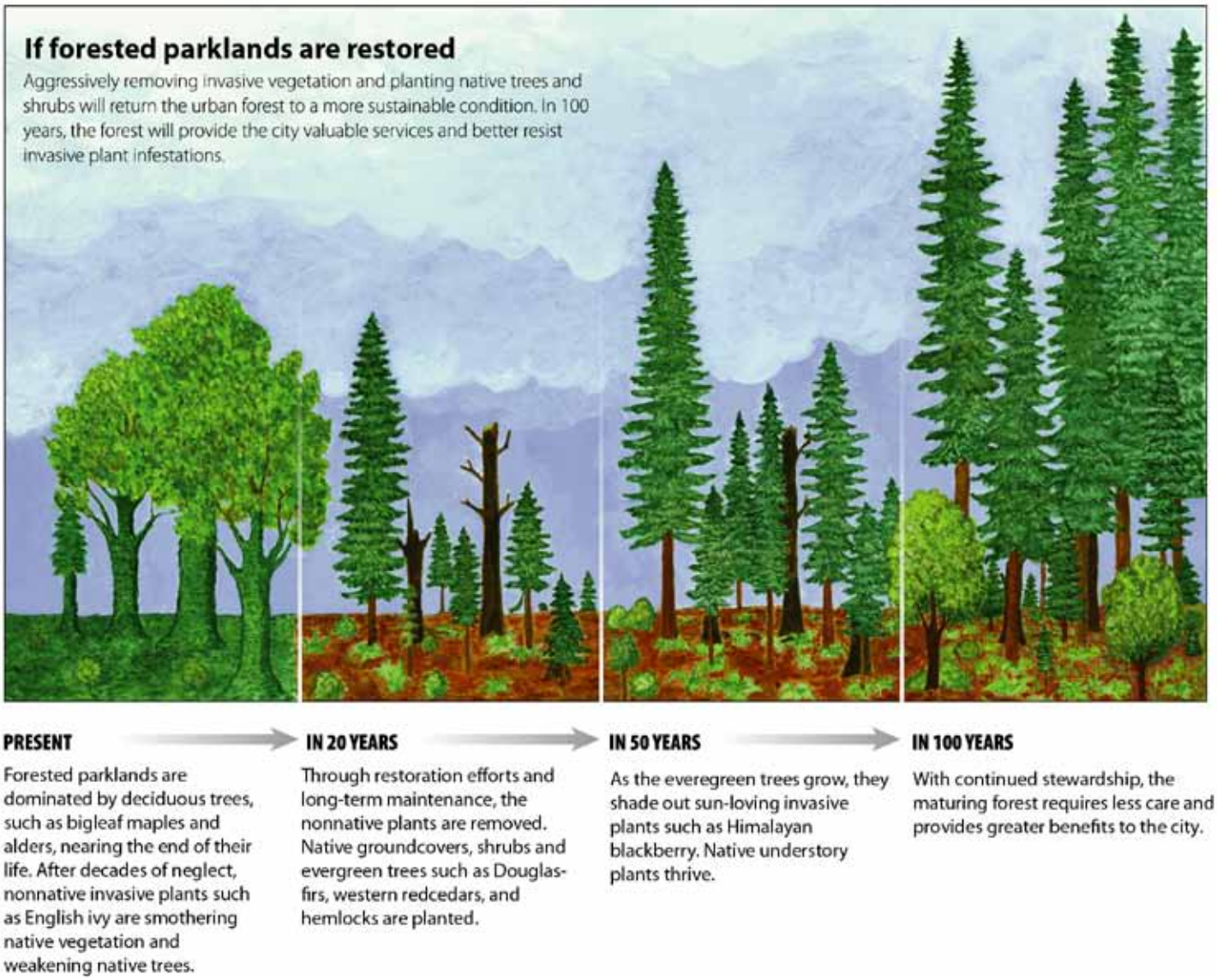


Figure 3: A projection of forest restored

OUTCOMES

Achieving the Green Tukwila Partnership's long-term vision will benefit the city in a variety of ways. Specifically, the Partnership anticipates that success will bring the following outcomes:

1. Improved health of Tukwila's urban forest and natural open space, with all 138 acres enrolled in restoration and active maintenance.
2. Quality-of-life enhancement through the public's increased use and enjoyment of a healthy, safe, accessible urban environment.
3. Positive economic and public health effects and enhancement of ecosystem services that a healthy urban environment provides (cleaner air, cleaner water, stormwater retention, safe access to recreation, wildlife habitat, community building, civic pride, and more).
4. Residents and employees of local businesses have a high ownership stake in, and appreciation for, the city's urban forest and natural open spaces.

GOALS

For the Green Tukwila Partnership's mission to succeed and for the vision and desired outcomes to become a reality, certain goals must be achieved during the next 20 years. The following goals, along with measurable benchmarks (see Appendix H), were developed based on current habitat conditions, current capacity to support restoration efforts, and the experience of other partnerships in the Green Cities Network. Chapter VI, Adaptive Management, describes the process of monitoring and tracking the program's success in more detail.

1. Identify priority sites for restoration and maintenance, and implement enrollment according to available resources and funding.
2. Develop stewardship plans for priority sites to support restoration implementation.
3. Host community events that foster the use and enjoyment of, and connection with, forested parks and natural open space in ways that are relevant to Tukwila's diverse community and provide an introduction to stewardship
4. Recruit, retain, and support volunteers in meaningful restoration and stewardship projects in local parks and open spaces.
5. Develop a Steward program that empowers a growing number of dedicated participants to take a leadership role in restoration.
6. Build collaborative working relationships among government agencies, nonprofits, schools, and other partners, beginning with the formation of a Green Tukwila Management Team.
7. Establish resources to sustain the program for the long term.
8. Celebrate the Partnership's success.

Photo by McRob

PARTNERSHIP ROLES AND CONTRIBUTIONS

Based on the experience of the other Green Cities, this section describes a management-structure model that has been modified for the Green Tukwila Partnership (described in Table 3). The structure is intended to support several thousand community volunteers, city and nonprofit staff, and skilled field crews, who will implement the Partnership by performing the work needed to achieve plan goals. In the Partnership's first two years, a primary task will be planning and decision-making, working closely with Forterra as necessary to establish a strong program. Once the program is up and running, the Partnership will expand the Management Team to help guide the program's planning and implementation to achieve plan goals. All three program areas (community, fieldwork, and resources) should be part of this process, including tracking and reporting each area's progress. In the first five years, the focus is on building and supporting a volunteer base, spreading program awareness, and demonstrating restoration results on the ground. As community support becomes established, staff time can be reallocated to the fieldwork component, especially for volunteer management and coordination of the work done by Stewards and skilled field crews.

Support staff will help facilitate implementation work by coordinating resources and communication across the Partnership. There will also be a need to seek the necessary near-term funding and resources to help meet program goals. Partnering organizations, such as Forterra, EarthCorps, and other organizations and businesses, can help provide staff, support, and resources not available through the City of Tukwila.

During these initial years, the Tukwila Parks Commission will provide guidance and oversight in coordination with the Green Tukwila Partnership Management Team. If there is enough support from interested Tukwila residents, the Partnership may benefit from establishing a Community Advisory Committee. This committee could include community members and representatives from major donors and local corporate sponsors, along with the city and Forterra. The key roles of the Community Advisory Committee could be to advance the larger goals of the Partnership, provide guidance regarding budgets and funding, and garner community support.

All of this is designed to provide resources to support and track on-the-ground fieldwork undertaken by volunteers and skilled field crews (city staff, nonprofits, and other professional contractors). Without advance planning and structure for the Green Tukwila Partnership, the fieldwork will not be as successful, efficient, and organized as it should to achieve the plan's goals during the next 20 years.

City of Tukwila

Parks and Recreation

The City of Tukwila Parks and Recreation Department currently manages the majority of the sites within the Green Tukwila project area. Parks has a supply of field equipment that may be available for restoration on natural area sites. However, the Maintenance Division's crew is currently at ca-

Photo by McRob

pacity addressing Parks' ornamental plantings and lawn areas.

Parks staff members based at the Tukwila Community Center currently do outreach and volunteer recruitment for a variety of city projects. They already help promote restoration projects at Forterra and EarthCorps sites, and will continue to promote additional Green Tukwila Partnership projects. However, more capacity would be needed to expand this role.

Public Works

The City of Tukwila Public Works Department currently has one Habitat Project Manager dedicated to mitigation, levies, and grant-funded projects on City property. Duwamish Gardens is an example of a new off-channel habitat-restoration project overseen by Public Works staff that will, once completed, be handed over to Parks to manage. The Habitat Project Manager has a high degree of knowledge of restoration ecology, and as such will continue to provide advice to the Partnership regarding site-management best practices.

Community Development

The City of Tukwila Department of Community Development also has a staff members who will provide oversight for the Green Tukwila Partnership, primarily the Environmental Specialist. The Environmental Specialist is familiar with many of the sites in the Green Tukwila project area, especially those containing sensitive areas and shorelines. However, this position is half-time, and more capacity would be needed to expand this role.

Seattle City Light

Green Tukwila sites under the ownership of Seattle City Light include the three properties in the Creston-Duwamish Green Line, the restoration corridor under and along the transmission line between the Creston and Duwamish substations. These sites are Ryan Creek, Ryan Hill, and Duwamish Hill. An additional consideration for these sites is the restriction on the height of trees under transmission lines. There is currently a project being planned for restoration on these sites with native shrubs and groundcover plants that will attract and provide habitat for pollinators, such as bees, butterflies, birds, and moths. There is already some volunteer engagement on these sites.

King County Parks

Five sites within the Green Tukwila project area are currently owned by King County Parks: Foster Point Lookout Park, P-17 Pond, Cecil Moses Memorial Park, Chinook Wind, and North Wind's Weir. EarthCorps' Puget Sound Stewards program has been an active partner is restoration of the last three sites listed above. EarthCorps will continue to help steward these sites as funds are available in coordination with King County.

Tukwila School District

The Tukwila School District owns several properties included in the Green Tukwila Partnership project area: Tukwila and Thorndyke Elementary Schools, Showalter Middle School, Riverton Park, and Foster High School. The properties with on-site schools present excellent opportunities to involve students and classes in stewardship. The School District's communications staff will help find opportunities for the Partnership to reach students and families.

Highline School District

Crestview Park is the only site in the project area owned by the Highline School District. Currently there is no school located on the property. Crestview is a great neighborhood park that would be a good potential early restoration site. The City of Tukwila will act as an intermediary to the School District until we are ready to bring this site into active restoration.

Washington State Department of Transportation

The West Valley Riverbank is the only Green Tukwila site under the ownership of the Washington State Department of Transportation (WSDOT). As a significantly sized stretch of Duwamish River shoreline, it is an important restoration site. However, as a tree-iage category 9, with additional access limitations, it is a low priority for the first few years of the Partnership. Green Tukwila Partnership staff will coordinate with WSDOT later in the program timeline when resources are available to begin work on this site.

Washington State Department of Natural Resources

The Nelsen Site is the only Green Tukwila site under the ownership of the Washington State Department of Natural Resources (DNR). This site is divided into parcels, some of which are under the ownership of the City of Tukwila. The Nelsen site also includes some Duwamish River shoreline and side channels, and so is an important restoration priority for ecological reasons. However, like the West Valley Riverbank, it is identified as a tree-iage category 9 site with difficult access and would be a low priority for restoration or community engagement. When the Nelsen Site is enrolled into active management, Green Tukwila staff will coordinate with DNR.

Nonprofit Organizations

Forterra

Forterra is the state's largest conservation and community-building organization working to create great communities and conserve great lands. Forterra's Green Cities Department supports all Green City Partnerships in some way, and works to keep all Partnerships connected through the Green Cities Network. The Green Cities Network facilitates quarterly focus groups open to all Partnership staff; distributes training, grant, and other announcements via the Network listserv; and offers technical and general assistance to participating Green City partner agencies.

Forterra has already been invested in ongoing restoration in Tukwila at the Duwamish Hill Preserve and the Duwamish Shoreline Restoration Challenge site for many years. The organization will continue its commitment to doing work on these sites, and hopes to expand its work in Tukwila as resources allow. Forterra will be an active member of the Management Team.

Forterra will continue to work alongside partner agencies and the public to articulate and advance the goals of the Green Tukwila Partnership. Forterra may also provide additional skilled field crews, program management, outreach, marketing, development, and greater coordination and connection to the regional Green Cities Network, if needed, through possible future grants or contract funding.

EarthCorps

With more than 20 professional staff and nearly 50 young adult corps members working full time throughout the year, EarthCorps has nearly 25 years partnering with local municipalities, nonprofits and community groups on habitat restoration projects in our region. EarthCorps professional resources include highly trained crews working year round; a group of long-term volunteers who adopt restoration sites (Puget Sound Stewards); a team of volunteer coordinators and volunteer specialists who lead 10-12,000 youth and community volunteers annually; and a professional staff that includes project managers and ecologists skilled in developing vegetation management plans as well as mapping and monitoring restoration sites.

The Student Conservation Association

The Student Conservation Association (SCA) runs youth crews that work on environmental stewardship projects. In the Seattle area, the SCA's summer crews for high school students present an excellent opportunity to connect the need for restoration at Green Tukwila sites with youth employment and job-skills training. High School members are paid an hourly minimum wage rate. The SCA already recruits crew members from Foster High School, and will seek to deepen its relationship in Tukwila as the Green Tukwila Partnership grows. SCA staff may join the Green Tukwila Management Team as appropriate.

ECOSS

The Environmental Coalition of South Seattle (ECOSS) currently runs a program for newly arriving residents to the city, particularly the immigrant and refugee communities. The program helps them get to know their new home and its surrounding environment by offering information on issues such as accessing and using public natural areas; and the permits, rules, and regulations regarding harvesting and recreation. The Green Tukwila Partnership will look for ways to partner with ECOSS to create programming and events that are culturally appropriate, appealing, and accessible to Tukwila's large immigrant and refugee communities, and that celebrate their use of public parks and natural areas. ECOSS staff may join the Green Tukwila Management Team as appropriate.

Other organizations

It is the Partnership's intent to look for opportunities to

collaborate with organizations that share common goals. Reaching out to various nonprofit organizations and community groups that serve the Tukwila area and finding arenas for mutually beneficial work will strengthen and leverage community support for the program. Additional groups may supplement work performed by Green Tukwila partner agencies in the following capacities:

- Organize, recruit, support, lead, and/or train community volunteers.
- Facilitate involvement of Tukwila residents, or civic, business, and community organizations.
- Perform restoration work in areas that cannot be served by volunteers or in areas where the Partnership directs such work.

Volunteers and the Community at Large

Volunteers donate their time to the Partnership by helping to restore and maintain forested parks and natural areas, leveraging the financial resources of Green Tukwila partner agencies and allowing more areas to be actively cared for. They bolster community interest and support for local parks and natural areas through their advocacy, and build critical local ownership of, and investment in, public spaces. A key responsibility of the Partnership will be to work with community members to provide field leadership training, site planning assistance, support, and encouragement. Volunteers committed to a restoration site in their local park will be encouraged to take on additional responsibilities and receive special training as Stewards. An active and educated group of Stewards is essential to expanding the Partnership's capacity to work in many parks simultaneously, and will help shape the work to fit the needs of particular neighborhoods and communities. Individual volunteers and groups will be recruited to help Stewards with their forest-restoration projects.

Commercial and Nonprofit Field Crews

Professional field crews and contractors will complement the work of volunteers in achieving restoration goals. Professional crews typically focus on steep slopes and other sensitive areas not appropriate for volunteers, or projects that require technical expertise beyond the scope of volunteers. Several local training crews, including EarthCorps, the Student Conservation Association, Washington Conservation Corps,

Photo by McRob

Photo by Billy Hustace

Photo by McRob

Duwamish Valley Youth Corps, and Duwamish Infrastructure Restoration Training (DIRT) Corps, provide excellent opportunities to get restoration work done in Green Tukwila sites, along with employment and job-skills development for local residents, especially youth.

Funders, Donors, and Sponsors

This plan was made possible, in part, through a generous grant from The Boeing Company. Corporate sponsors like Boeing, foundations, private donors, and other grant-making entities are key partners and stakeholders in the Green Tukwila Partnership. These stakeholders may be able to help address funding gaps in implementing the program.

Corporate sponsors will also have opportunities to support the Partnership beyond financial donations. Many businesses offer their employees opportunities to volunteer for various community projects. Corporations and local businesses will be invited to participate in volunteer restoration events, providing a substantial volunteer labor resource. Sponsors may also be asked to make other contributions as appropriate. For example, it is not uncommon for firms to help defray expenses by donating event supplies, coffee and snacks, or services such as graphic design, advertising, or event planning

Guide	**City Council** Provides policy for larger Partnership goals and resource allocations.		
	Parks Commission Provides advisory guidance and connection to the residential community.		
Plan	**Green Tukwila Management Team** Implements Partnership goals, creates work plans, tracks accomplishments, and manages the Partnership's resource allocations. The Management Team is made up of partner agency staff involved in active work. As the Partnership grows, the Management Team may form committees, which may include interested members of the public, to meet separately to address certain areas of work (for example: fieldwork, public engagement, etc.).		
Implement	**Public** • City of Tukwila • King County Parks • Seattle City Light • Tukwila School District • Highline School District • WSDOT • Washington State Department of Natural Resources • Volunteers	**Nonprofits** • Forterra • EarthCorps • SCA • ECOSS • Others	**Private** • Contractors and consultants • Local business partners • Property owners

Table 3: Green Tukwila Partnership management structure

that can be provided through their companies. In return, these corporations receive the opportunity to engage with the community and contribute to a healthier, more livable urban environment.

Private Landowners

Private and public lands create a patchwork of natural areas across the City of Tukwila. Private lands serve as vital connectors between fragmented public green spaces. Many of the pressures on Tukwila's forested parks and natural areas are related to actions on adjacent private land, which can either enhance surrounding public spaces or lead to their degradation.

Landscaping choices or lack of maintenance on private property is a major source of invasive plants that spread to public parks. Illegal dumping of yard waste on park property also leads to the spread of invasive plants and smothers healthy plant communities. Tukwila landowners who live adjacent to forested parks are encouraged to be more active in stewardship of their land. Efforts to educate landowners about the benefits of native shrubs and trees, and the problems of invasive species such as English ivy, can play a key role in preventing the continued spread of invasive species throughout the city. Working with landowners through education programs, landowner-incentive stewardship programs, and other complementary programs for private property, will help the Partnership generate a community that cares about the well-being of natural areas, both on their own lands and in public spaces. Engaging these landowners as invested stakeholders will mobilize an important corps of advocates and volunteers to reverse the trend and improve the health of their property and the parks.

IV. FOREST AND NATURAL AREAS ASSESSMENT

Effective and efficient natural-resource management can only be accomplished if planners, field staff, and decision makers have the environmental information on which to base restoration actions. Armed with clear, systematically collected data, the Partnership will be able to understand on-the-ground conditions, identify the strategies and resources needed to accomplish the work, and identify priorities.

In 2015, the Green Tukwila Partnership conducted a forest assessment to characterize habitat conditions across the city's parklands and develop its citywide restoration plan.

METHODS

The habitat assessment focused on the 138 acres of forested and natural area parkland owned and managed by the Partnership's agencies. The parcels included in the Partnership's scope are those that currently support, or have the potential to support, (1) native lowland-forest communities with tree canopy cover greater than 25% and (2) forested and shrub-dominated wetlands or emergent wetlands that do not support a full tree canopy. While landscaped parks and street trees provide important ecological benefits and should be targeted for maintenance, they have not been included in the current scope of work.

Tree-iage and the Forest Landscape Assessment Tool

Baseline ecological data was collected during the fall of 2015 using a rapid-assessment data-collection protocol called the Forest Landscape Assessment Tool (FLAT), developed by the Green Cities Research Alliance (www. fs.fed.us/pnw/research/gcra; see "Urban Landscape Assessment"). FLAT is based on the "tree-iage" model, originally developed by the Green Seattle Partnership. Tree-iage is a prioritization tool, based on the concept of medical triage, that uses habitat composition (e.g. canopy cover or native plant cover) and invasive plant cover as the two parameters to prioritize restoration (Ciecko et al. 2016).

The FLAT adaptation builds on the existing framework of the tree-iage model to characterize additional habitat attributes beyond tree canopy and invasive plant cover. These include tree age and size class, native understory species present, and indicators of threats to forest health, including low tree-canopy vigor, root rot, mistletoe, and bare soils due to erosion. The presence of regenerating trees (canopy species less than 5 inches in diameter at breast height)—which play an important role in the long-term sustainability of the forest—was also documented. In addition, each stand was deemed "plantable" or "not plantable" based on whether site conditions were appropriate for tree-seedling establishment.

Rapid-assessment methodologies such as FLAT produce a snapshot of the overall condition at any one site and on a landscape or city scale. The data serves as a high-level baseline from which finer-scale, site-specific restoration planning can be conducted; site-by-site analysis will need to be done as work progresses to help ensure the most appropriate restoration practices and species composition are chosen for each site. Green Tukwila partners will continue to develop more-detailed site-level stewardship plans to further assess planting conditions and outline management recommendations as more park sites are prioritized for restoration activities.

Prior to field data collection, natural areas within the Green Tukwila Partnership project area were classified through digital orthophoto interpretation, dividing each stand into one of five categories: forested, natural, open water, hardscaped, or landscaped. These initial stand-type delineations were ground-verified in the field, and if necessary, the delineations were corrected or the boundaries were adjusted in the GIS. The delineated stands are referred to as Management Units (MUs). All MUs were assigned unique numbers to be used for field verification and data tracking. Hardscaped and landscaped areas, since they are not suitable for active native vegetation management, were removed from the total acreage targeted by the Partnership.

In the field, each MU was surveyed to identify its specific habitat type (e.g., conifer forest, deciduous forest, riparian shrubland, etc.). MUs were also surveyed to capture information on primary and secondary overstory species and size class, as well as primary and secondary understory species. (Primary refers to those species most abundant in the MU, and secondary refers to the second-most-abundant species.) See Appendix B for the FLAT-modified data-collection flowchart for the tree-iage habitat composition component of the model.

From this data, each MU was assigned a value (high, medium, or low) for habitat composition, according to the following breakdown:

HIGH:

MUs with more than 25% native tree-canopy cover, in which evergreen species and/or madrones make up more than 50% of the total canopy.

OR, MUs with more than 25% native tree canopy in partially inundated wetlands that can support 1%–50% evergreen canopy.

OR, MUs in frequently inundated wetlands that cannot support evergreen/madrone canopy.

MEDIUM:

MUs with more than 25% native tree-canopy cover, in which evergreen species and/or madrones make up between 1% and 50% of the total canopy.

OR, MUs with less than 25% native tree canopy in partially inundated wetlands that can support 1%–50% evergreen/madrone canopy.

LOW:

MUs with less than 25% native tree-canopy cover.

OR forests with more than 25% native tree canopy, in which evergreen species and/or madrones make up 0% of the total canopy.

In addition, each MU was assigned one of the following invasive-cover threat values:

HIGH: MUs with more than 50% invasive species cover.

MEDIUM: MUs with between 5% and 50% invasive species cover.

LOW: MUs with less than 5% invasive species cover.

Tree-iage Categories

After habitat-composition and invasive-species-cover values were assigned, a matrix system was used to assign a tree-iage category or priority rating for each MU (Figure 4). Categories range from one to nine. One represents high-quality habitat and low invasive-species threat, and nine represents low-quality habitat and high invasive-species threat. An MU that appears in tree-iage category three scored high for habitat value and high for invasive cover threat. MUs scoring low for habitat value and medium for invasive cover threat were

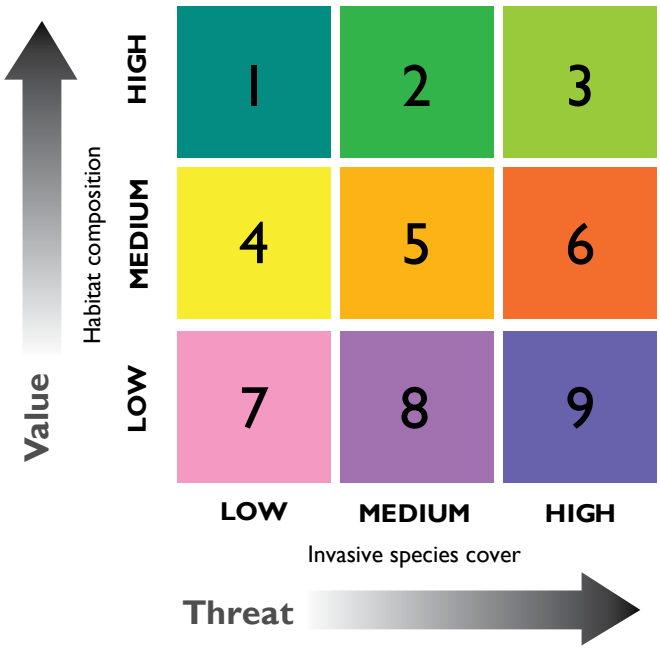


Figure 4: Tree-iage legend

Photo by McRob

Photo by Norah Kates

assigned to category eight based on the tree-iage model.

It is important to reiterate that this data was collected to provide a broad view of the habitat conditions of Tukwila's natural open spaces. Data collection occurred at the management-unit scale. But because MUs are different sizes (ranging from 0.02 acre to 9.14 acres), results are presented here using average conditions associated with each MU. Small pockets within MUs may differ from the average across the stand. When the plan refers to specific data in a given area, the term "MU acre" will be used. Keeping in mind the purpose of the FLAT analysis, this assessment will help prioritize restoration efforts during the next 20 years. The data gathered will also serve as a baseline from which the effectiveness of restoration efforts and the long-term health of Tukwila's forests and natural areas can be assessed in the future.

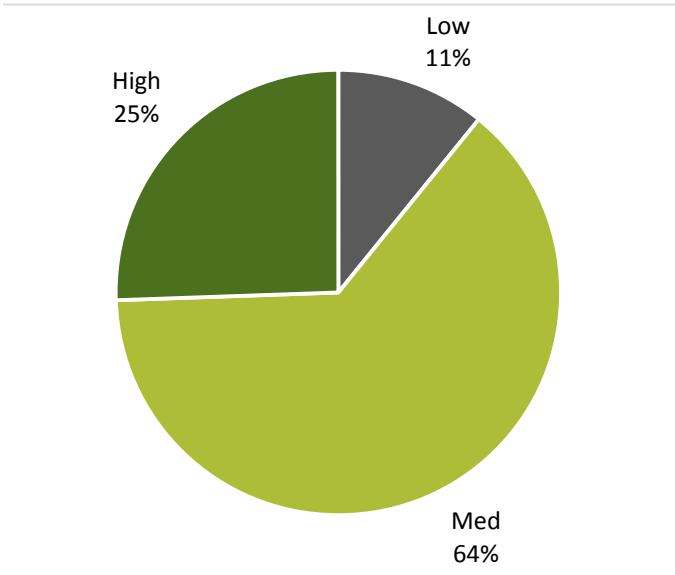


Figure 6: Canopy composition

RESULTS

Tree-iage Matrix

From the data gathered on all MUs during the FLAT assessment, a picture of Tukwila's forests and natural areas begins to form. Figure 5 shows the distribution of acres in each tree-iage category. By summing the acres in each row and column, one can see how much of the total project area (138 acres) currently has low, medium, or high habitat value, and how much currently has low, medium, or high threat from invasive species.

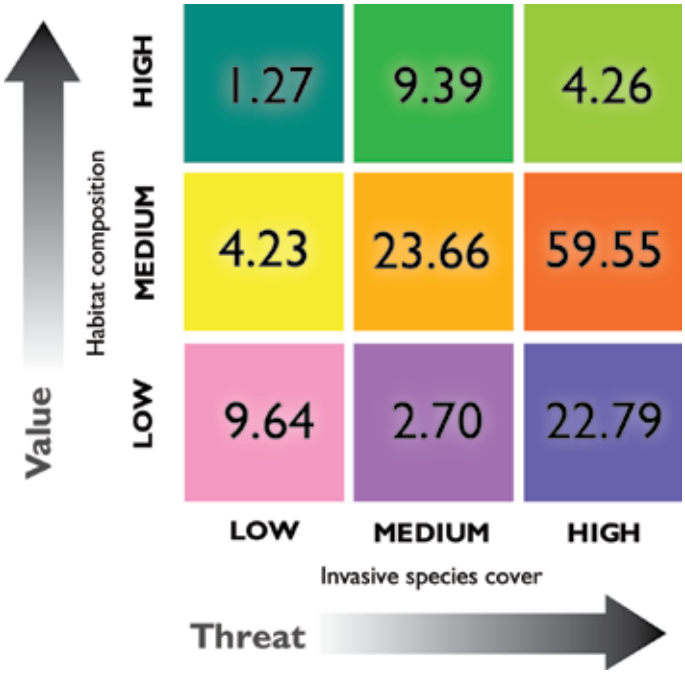


Figure 5: Distribution of management acres across tree- iage categories

This data informs the cost model discussed in Chapter V and is used to develop high-level cost estimates for the Partnership to consider when planning the next 20 years.

As seen in Figure 5, just one percent of the Green Tukwila Partnership project area is in exceptional condition (tree-iage category 1) with high-value habitat and low invasive-cover threat. Looking only at the first axis of the tree-iage matrix, habitat composition, categories 1, 2, and 3 combined represent 11% of the acreage (see also Figure 6). Over half of the acres have medium canopy composition (64% in categories 4, 5, and 6). And about 25% of the acres fell into the low-value habitat range (categories 7, 8, and 9).

The second axis of the tree-iage matrix is the threat from invasive species, which is based on the percentage of the MU that is covered by invasive species (see also Figure 7). Sixty-three percent of Tukwila's forested and natural area parklands have a high invasive species threat (categories 3, 6, and 9). Twenty-six percent of the project area falls in the medium category (categories 2, 5, and 8) for invasive species threat and 11% has low invasive species threat (categories 1, 4, and 7). Appendix C lists the tree-iage category acres per MU acre per park.

Overstory Species

The 2015 FLAT results show that Tukwila's forested parks and natural areas are dominated by middle-aged stands of primarily deciduous tree species, including black cottonwood, bigleaf maple, and red alder. Some mixed stands of conifer/deciduous canopy include Douglas-fir and, to a lesser extent, western redcedar. Mature black cottonwood and bigleaf maple were documented as the most dominant overstory species (Figure 8). Note that trees were recorded in order of dominance within each MU. Primary refers to acres where the species is dominant, secondary is second most dominant within a given MU, and tertiary is where the species is third most dominant within a given MU, measured in acres of each respective MU.

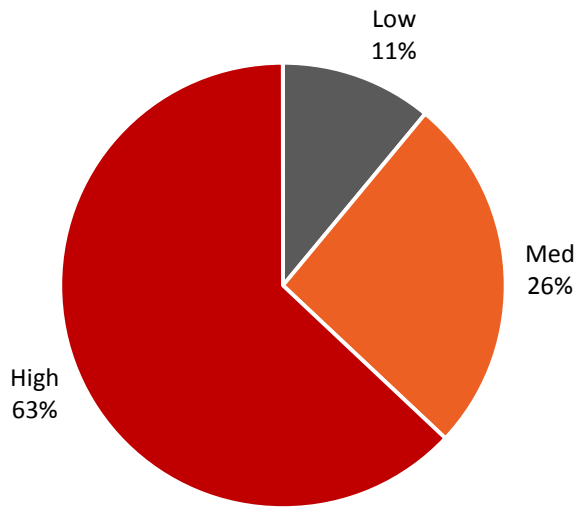


Figure 7: Invasive cover

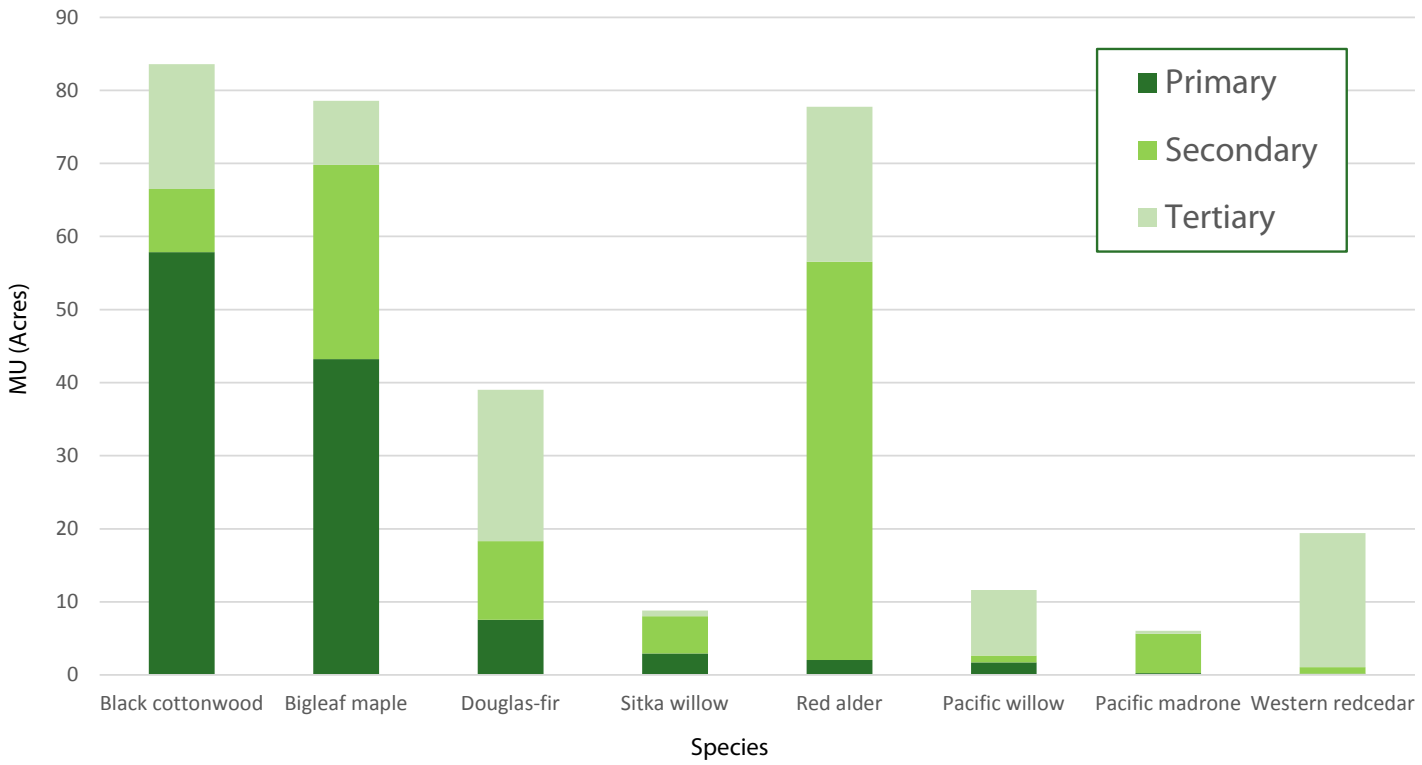


Figure 8: Distribution of overstory tree species by management-unit acres

Regenerating Overstory Species

The top five regenerating tree species documented include bigleaf maple, black cottonwood, Pacific willow, Douglas-fir, and red alder. Bigleaf maple is by far the most prevalent regenerating tree species in the Green Tukwila project area (Figure 9). Regenerating trees indicate the sustainability and future of the forest canopy, as these trees serve as the next generation of dominant overstory in Tukwila's parks and natural areas.

Native Understory Species

Tukwila's forested parks and natural areas have a variety of native understory species. Salmonberry, beaked hazelnut, snowberry, sword fern, and red osier dogwood are the most common (Figure 10). For a complete list of native understory species documented during the FLAT assessment, see Appendix E.

Invasive Species

Invasive species pose a very large threat to the understory in Tukwila's parks and natural areas. 86% of the acres in the project area were categorized as having a high level of invasive cover (over 50%).

In each MU, the top five most abundant invasive species were documented. Figure 11 illustrates the top five shrub and ground species, as well as the top three invasive trees. Himalayan blackberry and English ivy are the biggest threats. Out of 138 total acres in the project area, Himalayan blackberry was either the primary, secondary, or tertiary invasive species found in 120 acres. Reed canary grass and English laurel were also common, with other invasive species found throughout the project area. See Appendix F for a breakdown of all invasive species documented in the FLAT analysis.

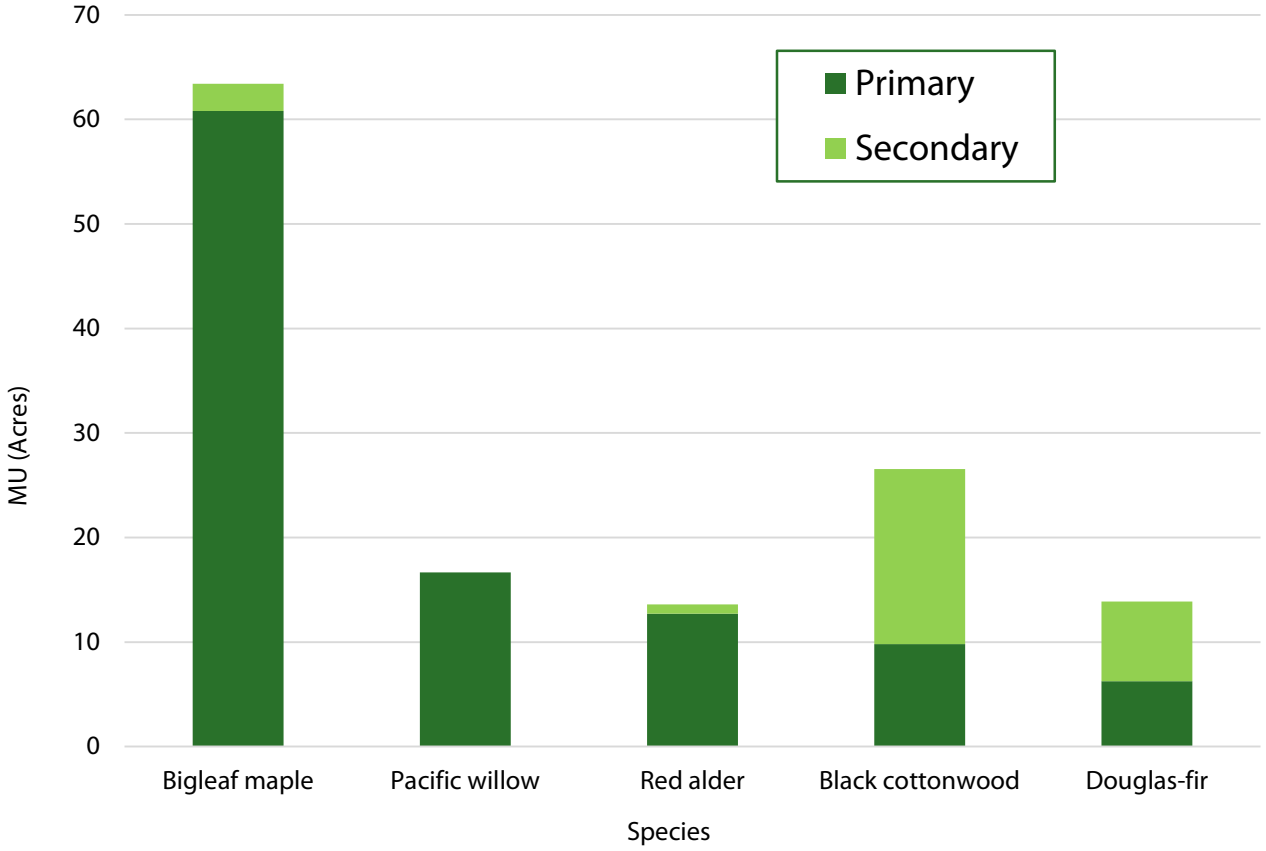


Figure 9: Distribution of top five regenerating overstory species by management-unit acres

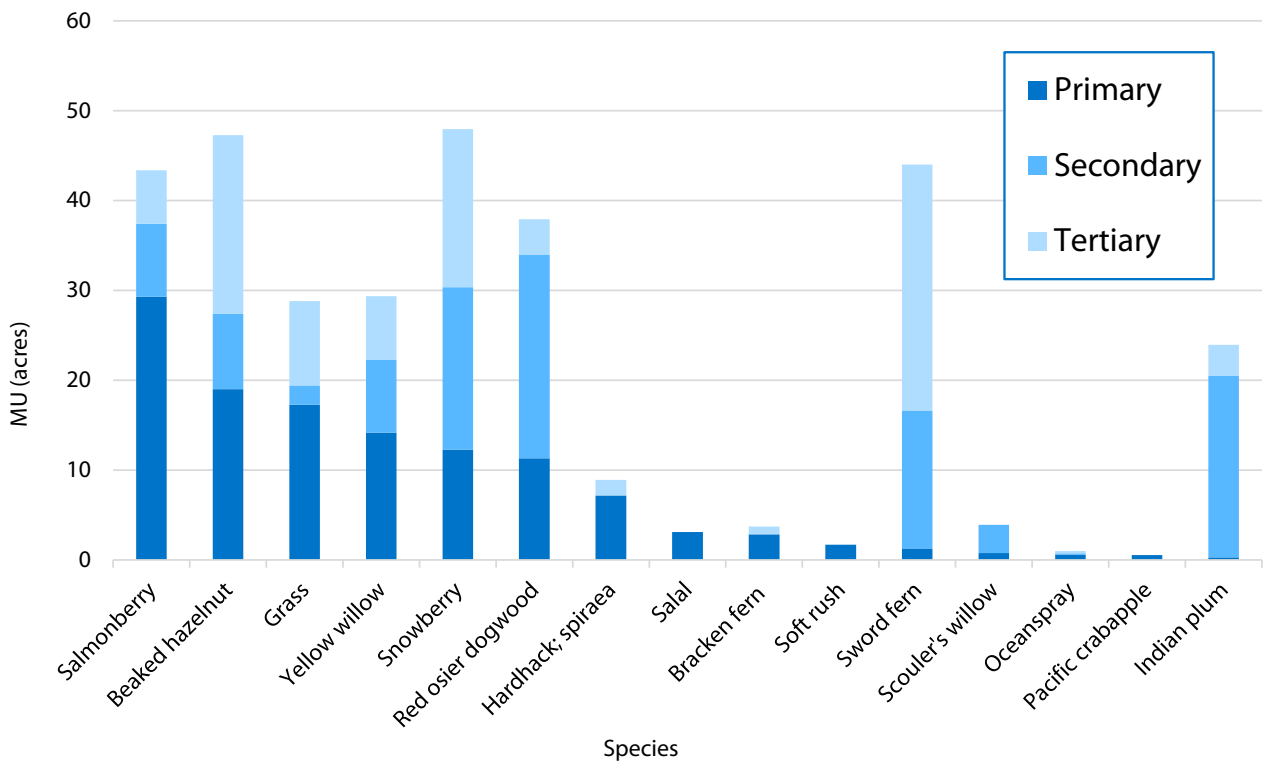


Figure 10: Distribution of most common native understory species by management-unit acres

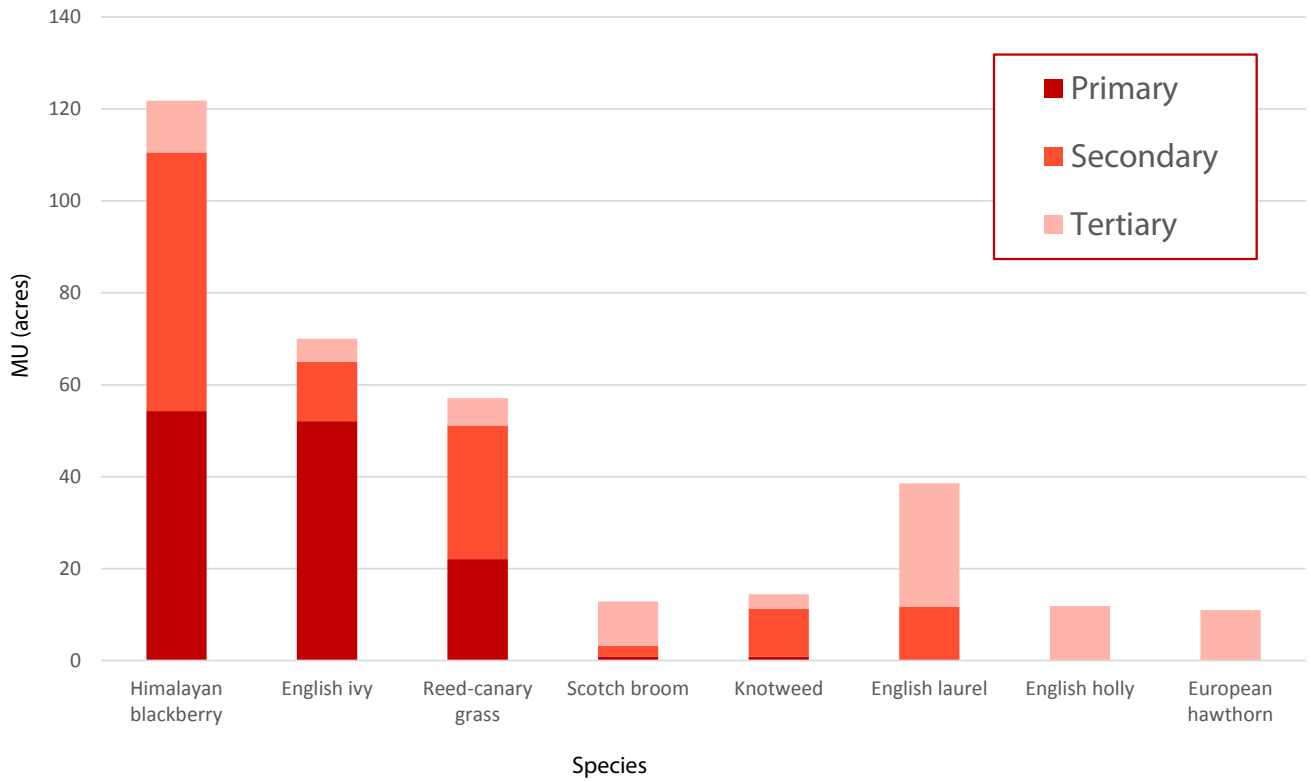


Figure 11: Distribution of most common invasive species by management-unit acres

Slope

Slope is also an important consideration, as it greatly affects the difficulty of restoration activities. For safety reasons, volunteers can only work on relatively flat terrain. Even professional crews need special equipment and training to work on steep slopes, which increases the cost of restoration significantly. For example, part of the Duwamish River shoreline are quite steep, which will require extra planning, professional crews and technical expertise. However, when comparing the Green Tukwila Partnership project areas with other Green Cities in the region, Tukwila has a relatively small percentage of acres that have steep slopes. According to the FLAT data that was collected; 47 acres are less than 20% slope; 83 acres are 20% to 40% slope; and only 7 acres are on slopes greater than 40%.

Photo by McRob

V. MOVING FORWARD – THE NEXT 20 YEARS

As in the other Green City Partnerships, a Balanced Scorecard approach is used to develop and adapt the Green Tukwila Partnership implementation strategy (see Table 11). The Balanced Scorecard is a widely used business tool that both helps develop a strategy and monitor progress as that strategy is carried out.

The Balanced Scorecard helps define and align the efforts of complex organizations to achieve targeted outcomes. With these metrics, the Partnership can track the success of various activities and set benchmarks during the plan's 20-year course. The traditional private-sector scorecard balances profits, customer satisfaction, and employee welfare by listing goals and quantifying measures that indicate if actions meet the goals. Its layers focus on increasing shareholder value. For the Green Tukwila Partnership, the layers are modified to reflect the ultimate goal of a healthy and sustainable network of natural open spaces. These layers include the plan's key elements: field, community, and resources.

The FIELD element looks at how on-the-ground strategies will be carried out to restore 138 acres of natural open space.

The COMMUNITY element assesses how an engaged community and a prepared workforce will be maintained in the long term, and how private landowners will be educated and encouraged to complement the Partnership's efforts.

The RESOURCES element examines how sufficient financial, staff, and volunteer resources will be garnered to implement the plan.

The three elements have reciprocal relationships. For example, volunteers are critical to accomplishing fieldwork, while demonstrating progress in fieldwork is essential to motivating and retaining volunteers. Similarly, the Partnership needs community support to secure the financial and volunteer resources to restore and monitor sites in the long term. By looking at the complete picture in layers that build on each other, the Partnership can coordinate efforts across various work areas so that activities are interconnected and mutually supportive.

The ability of managers to track progress during the next 20 years will allow challenges to be identified early. In response, managers can modify or adapt the program to address and resolve those challenges. See Chapter VI, Adaptive Management, for further discussion regarding the balanced scorecard and adaptive management.

FIELD

Active management of Green Tukwila Partnership sites will target removing invasive plants and establishing native vegetation as appropriate. The citywide habitat assessment of Tukwila's forests and natural area parklands will be used to assess progress in acres already enrolled in restoration, characterize baseline ecological site conditions of new acres, prioritize restoration efforts, and guide goal development.

Photo by McRob

Field Objective 1: Prioritize parks and natural open-space sites

Tree-iage analysis results show that there are 138 acres of forested parks and natural open space in Tukwila in need of various levels of restoration, maintenance, and long-term stewardship. To date, active partners (the City of Tukwila, Forterra, and EarthCorps) have ongoing restoration projects at six sites: the Duwamish Hill Preserve, Duwamish Shoreline Restoration Challenge Site, Codiga Park, North Wind's Weir, the Tukwila Community Center, and Cecil Moses Memorial Park. In addition, the City has projects under way at several sites, including the new off-channel habitat-restoration project at Duwamish Gardens. The projects have thus far been disconnected efforts. A goal of the Green Tukwila Partnership is to take a comprehensive look across the city and coordinate projects at different sites into a single overarching effort.

Currently active project areas will continue to be priorities for restoration in 2017. The Partnership will prioritize new sites based on a site's ecological condition, and community interest and investment (see Figure 12). The Partnership will try to ensure that restoration efforts are distributed throughout the city so that they are accessible from every neighborhood. For parks with an interested Steward or active volunteer base, sites will be chosen that are appropriate for volunteers (i.e., less than 40% grade) and where tools and restoration materials can be easily accessed. Since community engagement and education are key components in the Partnership's success, sites with high public visibility and high value to Tukwila residents will be chosen to extend education and program promotion.

Field Objective 2: Prioritize restoration work zones within sites

There are 53 sites included in the tree-iage analysis, each of which contains management units falling into up to seven different tree-iage categories, and each with different needs. As individual parks are enrolled into active management, forest stands and other natural areas within these sites should be prioritized for annual and multiyear restoration plans. Particular attention should be paid to existing projects to keep restoration efforts moving forward. Maintaining momentum and preventing sites from reverting to their previous condition were comments made frequently during the public-input phase of this plan development. As it is an inefficient use of resources, not only is "backsliding" expensive, but it is also particularly discouraging to the public. The second priority is to expand sites already enrolled in restoration by continuing to clear invasive species in areas contiguous with previously cleared sites.

As new sites are brought into restoration, the tree-iage model can be used within sites with multiple management units as a guide to anticipate needed restoration. For example, MUs

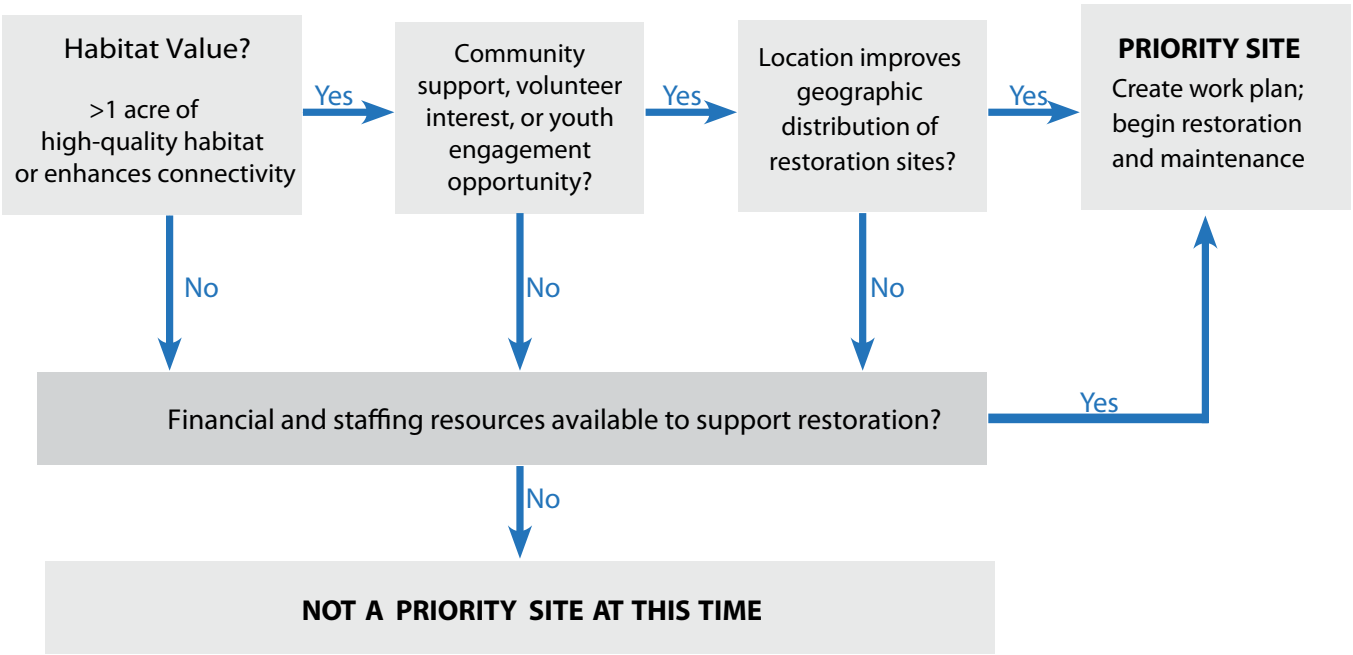


Figure 12: Decision tree for prioritizing restoration sites

with high-quality habitat and few to no invasive plants (tree-iage category 1) can immediately be given the protection of annual monitoring and maintenance. Other high-value habitats, including conifer-dominated forests or wetlands made up of a mosaic of native shrubs and emergent plants (tree-iage categories 2 and 3), will be considered high priorities for protection and restoration. Additional factors, such as public access and safety, and the presence of wetlands, streams, or shorelines are also taken into consideration. Providing maintenance for recently restored sites is a priority as well.

Field Objective 3: Identify areas that require professional crew and staff support

As noted above, not all restoration sites in the Green Tukwila project area are suitable for volunteers; some require the use of professional, trained field staff. Sensitive areas such as steep slopes, wetlands, and riparian buffers require the expertise and training of such staff. In addition, some best management practices require the use of herbicides, such as cut-stump treatments for invasive trees like English holly and cherry laurel, or stem injection for knotweed species that aggressively invade critical riparian habitat. Herbicide treatment must be conducted by a licensed professional staff member.

Sites that have support available through the City, partner or grant-funded crews will be given priority status for restoration, as well as those where noxious weed control is mandated by King County and that have support from the King County Noxious Weed Control Program (www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/program-information.aspx).

Field Objective 4: Implement best practices in restoration and stewardship on all project sites

Best Management Practices

Restoration ecology is an interdisciplinary science that draws from the fields of ecology, forestry, and landscape horticulture. As more restoration projects are completed in urban environments, field practices are refined and improved. Field experience and best available science will continue to be integrated to improve techniques and restoration success now and in the future. Ongoing restoration projects within the Green Cities Network and other partner natural-resource organizations will inform and guide best management practices (BMPs) for Tukwila's fieldwork. These BMPs include site planning, invasive control methods, planting and plant establishment, and volunteer management.

In 2012, the Green Seattle Partnership created a Forest Steward Field Guide of BMPs suitable for volunteer restoration work, which has since been updated by and adapted for other cities in the Green Cities Network. The Green Tukwila Partnership will create this field guide for Tukwila's Steward Program. Program staff and volunteer stewards will be trained in the BMPs. Supplemental coursework and training programs will be recommended for all staff involved in restoration and maintenance of Tukwila's forested parks and natural areas.

The Four-Phase Approach to Restoration Fieldwork

An important BMP, developed by the Green Seattle Partnership, is the four-phase approach to restoration fieldwork, which has been highly successful. It recognizes that restoration activities fall into four major phases, and that, at some sites, it takes several years to move through all the phases:

1. Invasive plant removal
2. Secondary invasive plant removal and planting
3. Plant establishment and follow-up maintenance
4. Long-term stewardship and monitoring

Because habitat health varies from site to site, and some work is ongoing, not every site will start at phase 1. Each site, however, will need to receive an on-the-ground assessment before work begins in the appropriate phase.

Phase 1. Invasive Plant Removal

The first phase aims to clear the site of invasive plants, focusing on small areas at a time in order to help ensure thoroughness and minimize regrowth. Specific removal techniques will vary by species and habitat type, and it may take more than a year to complete the initial removal.

Major invasive-plant reduction will be required on sites with 50% or greater invasive cover (high threat from invasive species: tree-iage categories 3, 6, and 9). Many of these areas will require skilled field crews or special equipment. Given the extent of invasive cover, these sites will also require a large investment of both funding and community volunteers to help ensure restoration success. Areas between 5% and 50%

invasive cover (medium threat from invasive species: tree-iage categories 2, 5, and 8) will also require invasive removal. Invasive growth in these spots is patchy. Generally, projects in these sites are appropriate for community volunteers. Areas with less than 5% invasive cover or less (low threat from invasive species: tree-iage categories 1, 4, and 7) require little or no removal, and phase 1 work in these areas may simply involve walking through to check that any small invasive growth is caught before it becomes a larger problem.

Phase 2. Secondary Invasive Removal and Planting

Before planting, a second round of invasive removal is done to target any regrowth before it spreads, and to clear the site for young native plants to be established. Staff will work with each site on a case-by-case basis to develop an appropriate plant palette and work plan.

For example, forested habitats with more than 50% conifer canopy cover (tree-iage categories 1, 2, and 3) will require the least amount of planting, but may need to be filled in with ground cover, shrubs, and small trees in the understory. Areas with more than 25% native tree cover but less than 50% conifer cover (tree-iage categories 4, 5, and 6) will generally be filled in with native conifer species. Areas with less than 25% native tree-canopy cover that can support tree canopy cover (tree-iage categories 7, 8, and 9) will require extensive planting with native trees, shrubs, and ground cover. Restoration practices and planting requirements will, of course, vary, depending on the habitat type and target native-plant population. Most phase 2 planting projects are appropriate for community volunteers. The Green Tukwila Steward Field Guide will provide volunteer-appropriate BMPs once a planting plan has been established.

Phase 3. Plant Establishment and Follow-up Maintenance

This phase repeats invasive plant removal and includes weeding, mulching, and watering newly planted native plants until they are established. Although native plants have adapted to the area's dry summer climate, installed container plantings and transplanted plants both experience shock, which affects root and shoot health; therefore, most plants require at least three years of establishment care to help ensure their survival. Sites may stay in phase 3 for many years.

Phase 4. Long-Term Stewardship and Monitoring

The final phase is long-term site stewardship, including monitoring by volunteers and professionals to provide information for ongoing site maintenance. Monitoring may be as simple as neighborhood volunteers patrolling park trails to find invasive species, or it could involve regular measuring and documentation of various site characteristics and plant survivorship rates. Maintenance will typically consist of spot removal of invasive regrowth and occasional planting where survivorship of existing plants is low. Individual volunteers or small quarterly or annual work parties can easily take care of any needs that come up, as long as they are addressed promptly before problems spread. The number of acres in phase 4 is programmed to grow every year, with the goal that all 138 acres will be enrolled in the restoration process and graduate to this phase.

Without ongoing, long-term volunteer investment in monitoring and maintenance of areas in restoration, Tukwila's natural areas will fall back into neglect. For that reason, volunteer commitment needs to be paired with city resources. Work is then compared against the best available science to define optimal plant stock and sizes, watering regimes, soil preparation, and other natural open-space restoration techniques.

Monitoring will be conducted more frequently in the early phases of the program as the Partnership discovers how the sites respond to restoration. Management units that currently have less than 5% invasive cover and more than 50% native conifer-forest cover or healthy wetland vegetation (tree-iage category 1) may already be in phase 4 and suitable for enrollment into a monitoring and maintenance plan. Most management units will need some preliminary restoration in phases 1 through 3.

In 2012, the Green Cities program developed a Regional Standardized Monitoring Program in order to understand the success, value, and effectiveness of restoration activities throughout the Partnerships. These protocols provide procedures for baseline and long-term data collection that can be replicated in the future to measure changes in site characteristics. The data shows the composition and structure of a site, which can be an important indicator of overall habitat health.

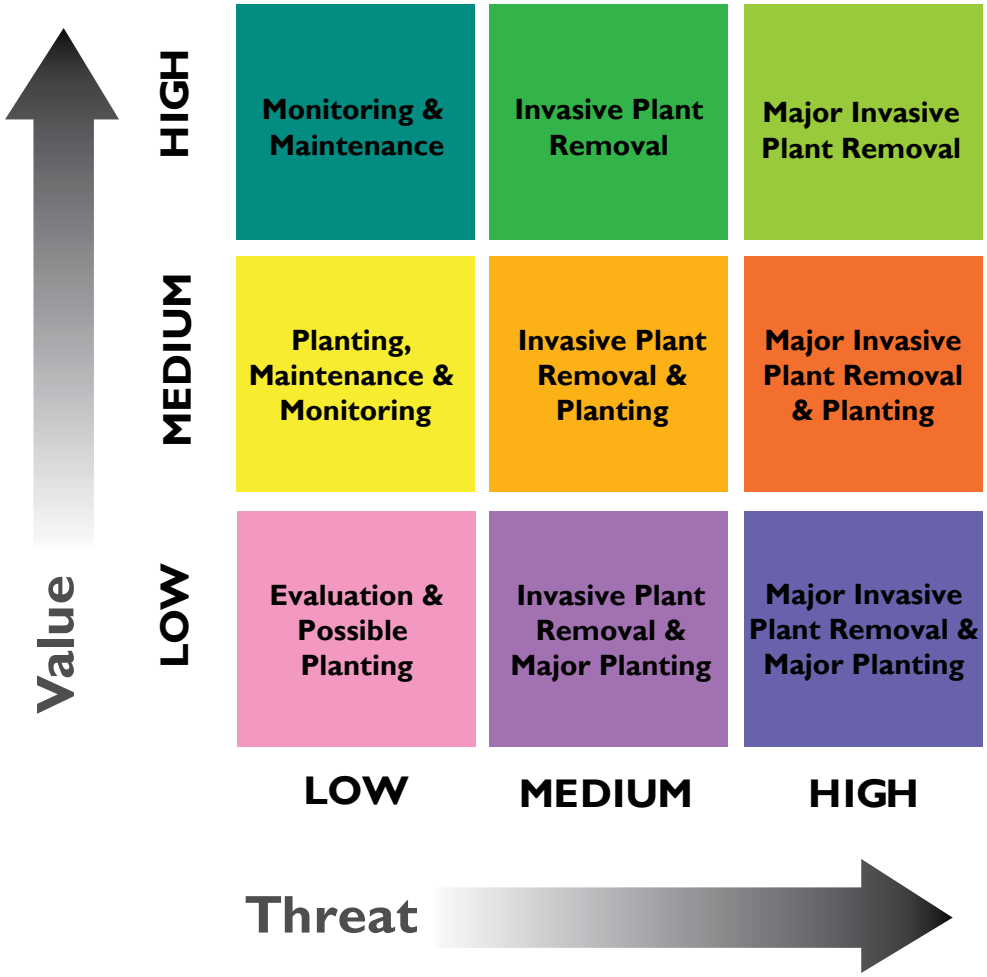


Figure 13: Restoration strategies and tree-iage categories

APPLICATION TO THE TREE-IAGE CATEGORIES

The four-phase approach can be applied to the tree-iage categories as shown in Figure 14. Each tree-iage category can be assigned appropriate management strategies.

TREE-IAGE CATEGORY 1: High Habitat Composition, Low Invasive Threat

Acres in project area: 1.27

Condition: This category contains the healthiest forest areas in the Tukwila system of natural open spaces. Typical stands have more than 50% evergreen canopy. This category includes stands of mature conifers and the mixed conifer/deciduous stands found in forested wetlands. In scrub-shrub or emergent wetland areas, where full conifer coverage would not be appropriate, this category has full cover by native vegetation appropriate to the site. These stands are under low threat because the invasive cover is less than 5%.

Management Strategy: Monitoring and Maintenance

Work is focused on protecting these areas' existing high quality and making sure that invasive plants do not establish themselves.

TREE-IAGE CATEGORY 2: High Habitat Composition, Medium Invasive Threat

Acres in project area: 9.39

Condition: Similar to category 1, these forest stands contain more than 50% conifer or evergreen broadleaf canopy or appropriate native wetland vegetation. Forests in this category are at risk because the invasive cover is between 5% and 50%. In these areas, invasive growth is expected to be patchy with diffuse edges.

A forest in otherwise good condition but subject to a number of moderate threats may degrade if left untreated. If unattended, this level of invasive coverage could prevent native seedlings from establishing and could compete with existing trees for water and nutrients. However, the forest would persist in good condition if threats were mitigated in a timely manner.

Management Strategy: Invasive Plant Removal and Prompt Action

The main activity is removing invasive plants. Typically, these sites will also require site preparation (e.g., mulching) and infill planting. Projects in these areas are appropriate for volunteers. Removing invasive plants from these areas is a very high priority for the first five years.

TREE-IAGE CATEGORY 3: High Habitat Composition, High Invasive Threat

Acres in project area: 4.26

Condition: As in categories 1 and 2, forest stands in this category have mature conifers, madrones, forested wetlands, or wetland vegetation where appropriate. Category 3 areas have a high threat from greater than 50% invasive cover.

A forest in this category is in a high-risk situation and contains many desirable trees or highly valuable habitat or species. If restored, forests in this category can completely recover and persist in the long term.

Management Strategy: Major Invasive Plant Removal and Prompt Action

Without prompt action, high-quality forest stands could be lost. Category 3 areas require aggressive invasive removal. Soil amendments and replanting are needed in most cases. Restoration efforts in this category are a top priority for the first five years.

TREE-IAGE CATEGORY 4: Medium Habitat Composition, Low Invasive Threat

Acres in project area: 4.23

Condition: Forests assigned a medium tree-composition value are typically dominated by native deciduous trees but have at least 25% native tree cover. Between 1% and 50% of the canopy is made up of native conifers. In wetland areas not suitable for conifers, these areas have between 1% and 50% cover by appropriate wetland vegetation. Category 4 areas have low levels of invasive plants, covering less than 5% of the management unit.

Management Strategy: Planting and Monitoring

We expect planting in these areas to consist of infilling with native species and establishing conifers to be recruited into the next generation of canopy. Often these sites require some invasive removal and site preparation (e.g., amending with woodchip mulch). Many of these sites may be converted to a conifer forest by the addition of appropriate conifer trees.

Addressing category 4 forests is a high priority during the first five years. They offer a high likelihood of success at a minimum investment. These sites are well suited to community-led restoration efforts.

TREE-IAGE CATEGORY 5: Medium Habitat Composition, Medium Invasive Threat

Acres in project area: 23.66

Condition: Areas in this category have between 5% and 50% invasive cover. Invasive growth is expected to be patchy with diffuse edges. These areas are estimated to have greater than 25% native canopy cover but less than 50% coniferous or broadleaf evergreen canopy cover. In the case of wetland forests, it is greater than 50% native tree canopy cover. In wetland areas not suitable for conifers, these areas have between 1% and 50% cover by appropriate wetland species. These forest stands contain many desirable native trees that are under threat from invasive plants.

Management Strategy: Invasive Plant Removal and Planting

These sites will require invasive removal and infill planting. While some restoration work is planned for these areas in the first five years, aggressive efforts are required throughout the life of the Green Tukwila Partnership.

TREE-IAGE CATEGORY 6: Medium Habitat Composition, High Invasive Threat

Acres in project area: 59.55

Condition: These areas are typically dominated by native deciduous trees but have at least 25% native tree cover. Between 1% and 50% of the canopy is made up of native conifers. In wetland areas not suitable for conifers, these areas have between 1% and 50% cover by appropriate wetland vegetation. Invasive plants cover more than 50% of the management unit.

A forest that retains important plant elements but is already partially degraded by a high-level risk factor may still have the potential to recover if remediation is prompt. Because these stands are at greater risk than category 5 forests, they also require greater labor investment.

Management Strategy: Major Invasive Plant Removal and Planting

Extensive invasive removal, site preparation (e.g., amending with woodchip mulch), and replanting are required. Initial invasive removal may be done with the aid of mechanical tools and equipment, and may require professionals. Planting in these areas consists of infilling with native species.

TREE-IAGE CATEGORY 7: Low Habitat Composition, Low Invasive Threat

Acres in project area: 9.64

Condition: These forests are estimated to have less than 25% native canopy cover in a setting that could support full canopy cover under good conditions. Forested wetlands will have less than 25% trees or shrubs appropriate to the site. Levels of invasive plants are low. Parks in this category may include areas with large canopy gaps (perhaps due to windthrow or die-off of mature deciduous trees), sites of recent landslides, unstable slopes, sites with large amounts of fill, and/or areas dominated by nonnative trees.

Management Strategy: Evaluation and Possibly Planting

The reasons underlying these sites' low value can differ greatly, and the stands will be addressed on a case-by-case basis. Because of low levels of invasive plants, restoration may be quite cost-effective in some sites. Sites will be evaluated to determine whether conditions and timing are appropriate to move these areas toward a more native forest and what the appropriate composition of that forest should be. In some cases, it may be desirable to remove nonnative trees, especially if they are aggressive. Areas that are ready for conversion to native forest would be a high priority during the first five years.

TREE-IAGE CATEGORY 8: Low Habitat Composition, Medium Invasive Threat

Acres in project area: 2.7

Condition: Areas that are estimated to have less than 25% native tree-canopy cover or forested wetlands with less than 25% cover by trees, and 5% to 50% invasive cover fall into this category. Invasive growth in these areas is likely to be patchy with diffuse edges. A forest in this category might be chronically degraded by a variety of threatening processes, and might have lost much of its value in terms of habitat quality or species complement.

Management Strategy: Invasive Plant Removal and Major Planting

Restoration efforts in these areas require a large investment of time and resources. Although some work will be directed here, this is not a priority category for the first five years. The Partnership will support efforts that contain the spread of invasive plants, try out new techniques, or help enthusiastic community-led efforts. These sites will require major invasive removal and site preparation, such as mulching and infill planting. Planting within these areas will consist of infilling with native species.

TREE-IAGE CATEGORY 9: Low Habitat Composition, High Invasive Threat
Acres in project area: 22.79

Condition: Areas estimated to have less than 25% native tree-canopy cover or appropriate forested wetland vegetation and greater than 50% invasive cover fall into this category.

Management Strategy: Major Invasive Plant Removal and Major Planting

Category 9 sites are not likely to get much worse during the next five years. These sites require many years of major invasive removal and site preparation in the form of mulching and infill planting, and will almost definitely require the attention of professionals. Although work will be directed to category 9 forests in the future, this is not a priority category for the first five years. The Partnership will support efforts that contain the spread of invasive plants, try out new techniques, or bolster enthusiastic community-led efforts.

COMMUNITY

Community Objective 1: Promote positive engagement with parks and natural open space

This is a major priority driving all the work of the Green Tukwila Partnership. We believe that Tukwila's residents, employees, and visitors deserve great parks and natural areas, and that they shouldn't have to travel far to get there. We want to make sure that there are places to enjoy nature, both for its environmental services as well as for its benefits for health and well-being, for the future of the city and its people.

Restoration and active maintenance are critical for the enjoyment of these natural areas, so that trees can thrive and we don't lose them altogether. Volunteer projects that build community among neighbors also increase a sense of ownership over public spaces and foster a special connection to them, in addition to just getting people outside. The Partnership will also plan and hold events that get more people out into Tukwila's parks and natural areas, and encourage and inspire them to see these places as the incredible public assets that they are.

Community Objective 2: Prioritize safety and use Partnership efforts to contribute to public safety in the city

Safety is also a key priority for the Partnership. Active maintenance and regular community events promote more active use of public spaces. As both volunteers and staff frequent a site, care and stewardship become evident and decrease the sentiment that parks are forgotten, abandoned places; as well, providing more "eyes on the park" discourages illegal activity. Safety concerns will also be taken into account in site selection.

Crime Prevention Through Environmental Design (CPTED), a set of landscape-design principles aimed at increasing safety, will be utilized in Green Tukwila projects. From relatively straightforward best practices in trail planning and maintenance to optimize safe view corridors, to complex challenges for activating spaces, these principles will provide valuable insights.

Community Objective 3: Develop and implement a community outreach and engagement plan to equitably serve Tukwila's diverse residential population

Tukwila's residential population is incredibly racially and ethnically diverse. Creating programs that are culturally relevant, accessible, and enjoyable for the many people who call Tukwila home will be essential to forming a Partnership that equitably serves this community. By continuing to build relationships with local organizations, community groups, and houses of worship, and by reaching out and listening to local residents, we hope to provide a variety of ways for them to engage with the Partnership.

There are two existing programs that have already had success in engaging Tukwila's recent immigrant and refugee community, and it would be a great asset to collaborate with them on stewardship efforts. The New Arrivals program, offered by the Environmental Coalition of South Seattle (ECOSS), helps recently immigrated residents get orientated to the parks system and can foster a positive relationship with local natural areas. The Community Connectors program, in partnership with the City of Tukwila, Global to Local, and Forterra, provides a way for residents from immigrant communities to voice their opinions and give feedback on community engagement efforts, thanks to the work of paid liaisons from within their own communities. Green Tukwila staff will work with both of these programs over the years to create events and experiences that traditionally underrepresented residents can relate to and enjoy.

Community building and an ethic of environmental responsibility are at the core of the Green Tukwila Partnership and the Green Cities Network across the Puget Sound. Community members are encouraged to participate in caring for our shared public urban forests and natural areas regardless of age, income, ethnicity, or languages spoken at home. Restoration volunteer projects provide an opportunity for neighbors, classmates, families, friends, and complete strangers to come together to restore health to their parks, build community through shared experience, and deepen ties to the natural world and each other.

The Green Tukwila Partnership seeks to build a successful volunteer program by strengthening efforts to provide equitable and inclusive opportunities for the entire Tukwila

community. Environmental conservation organizations across the country and here in Puget Sound typically have trouble engaging communities of color, recent immigrants, and low-income families (Taylor, 2014). Tukwila's population has become increasingly diverse, with Asian and Pacific Islander, African American, and Latino populations all highly represented at 19%, 18%, and 12% respectively, and the white population representing 44% of the community (Tukwila census, 2012). In addition to seeking opportunities to work with existing successful community-engagement programs, the Green Tukwila Partnership will need to employ additional creative strategies of its own during the next 20 years. The following is a summary of suggested strategies to enhance social equity and diversity, with input from Forterra and a diversity-engagement best practices pilot project researched and undertaken by the Green Redmond Partnership:

- Understand the demographics of Tukwila's neighborhoods as well as the needs and priorities of the communities that live there.
- Attend community association or other community-sponsored meetings, prioritizing those reaching communities of color, recent immigrants, and low-income families. Develop an understanding of this cohort's values and goals, and how Green Tukwila can support the neighborhood's own efforts to build community.
- Work cooperatively with human-services staff and local nonprofit organizations that work closely with low-income and traditionally underserved communities to create events that will be inclusive, relevant, and enjoyable.
- Work with local community groups to craft and host their own Green Tukwila events to increase inclusion in the planning process and create a strong community-driven program.
- Consider cultural competency training for Partnership staff and be mindful of differences within cultural groups. Don't make assumptions: be sensitive to the traditions and views of the groups the Partnership is working with.
- In an effort to ensure that public communication materials for projects or events can be understood by target residents, the Partnership can utilize King County's language-translation resources to conduct neighborhood-specific language-needs assessments. This resource is based on five sources of Limited English Proficiency data and includes GIS "language maps" that enable staff to identify the language needs of populations specifically. To help supplement the County's information, City staff can also utilize the Tukwila School District enrollment profiles for neighborhood schools.
- When working with Limited English Proficient volunteers, language interpretation should be provided throughout the volunteers' Green Tukwila experience, including during recruitment and pre-event communication, at the restoration event itself, and following the event, in order to build future engagement. The Partnership may choose to start with one language, such as Spanish, and build from there based on need and community interest.
- Create public-facing materials that specifically show diverse community members, so that potential volunteers can see themselves in Green Tukwila. Utilize inclusive language such as "everyone can help," and seek feedback from volunteers themselves on how to make events as welcoming as possible.
- Provide a continuum of opportunities in various parks and neighborhoods that are easily accessible and take specific transportation needs into account – whether that is public transit, available parking, walking access, or shuttles when possible. Identify other barriers to participation and address them as resources allow.
- Consider providing food and other hospitality. Sharing a simple meal together, even if it is a picnic at a natural area park, is an effective community-building tool and can be a great incentive to participation. Work with Healthy Tukwila (a program of the City of Tukwila) and other healthy food and local food programs to coordinate efforts. If working with a specific cultural group, research customs and norms, if any, surrounding food. When in doubt, ask community members about their preferences.
- Look for opportunities to connect with and celebrate different community's connections to the environment, green spaces, and/or volunteerism through cultural holidays or in other ways.
- Find new places to spread the word by asking community members where they gather and where they get news. Utilize ethnic media outlets, and post flyers in popular

local businesses.

- Focus on working with more volunteers of color, recent immigrants, and low-income families to move up the chain of engagement and become leaders in their own communities. Look for barriers to higher engagement and address them.
- Realize that volunteering and the free time required to do so is a privilege that is not available to everyone equally. Look for ways to make volunteer projects as accessible as possible, and to provide outdoor engagement and healthy, safe public spaces that benefit those who may not be able to volunteer. Use training and job-skills-development field crews as a way for more people to participate in the work of the Partnership.

Community Objective 4: Work with local businesses to encourage corporate support for the Partnership

Corporate support will be needed in order for the Partnership to reach its goals. Local businesses have already been involved in restoration projects in Tukwila, primarily through the Duwamish Shoreline Restoration Challenge. We will build on these relationships and expand to work with other businesses as well. Corporate support could come in the form of encouraging employees to volunteer, providing in-kind resources, or financial support through grants and donations.

Community Objective 5: Seek opportunities to engage youth and provide education

The Green Tukwila Partnership will work with the Tukwila School District to engage youth in outdoor experiences and environmental stewardship. Students at Tukwila Elementary School, Thorndyke Elementary School, Showalter Middle School, and Foster High School will be able to get involved with restoration and stewardship projects on their own campuses.

Studies have shown that students' productivity and creativity is increased by experiencing natural surroundings, due to nature's calming effect and its ability to reduce mental fatigue (Kaplan 1995 and Hartig et al. 1991).

By working with local partners providing engagement opportunities for youth at various ages, we will seek to create a pathway of engagement from elementary school through high school and job-skills training. Inspiring Connections Outdoors is a Sierra Club volunteer-led program that provides free fun, active, outdoor trips for students at Tukwila Elementary School and Showalter Middle School. The Student Conservation Association summer crews are a great opportunity for paid summer work and restoration-skills training for high school-age students. EarthCorps and DIRT Corps are local training crews for young people, who can make a living while contributing to projects that improve local environmental health. All these programs are currently available to Tukwila youth. The Green Tukwila Partnership will link them together, pursue funding opportunities that would provide support for all these efforts, and provide additional opportunities for youth and families to volunteer together in their local parks and green spaces, further improving their access to safe and healthy outdoor public places.

The Duwamish Valley Youth Corps, run by the Duwamish River Cleanup Coalition, brings together excellent environmental-justice education with restoration- and landscaping-skills training for middle and high school students. Currently, it is available for Seattle Youth, and members participate in projects in South Park and Georgetown. With sufficient funding, DRCC could run a similar program in Tukwila as part of the Green Tukwila Partnership.

Community Objective 6: Build a Steward Program to promote and support community leadership

The intent of the Green Tukwila Steward Program is to build an educated, engaged, and active volunteer base around restoration, maintenance, and stewardship of Tukwila's forested parks and natural areas. The program provides volunteers with an opportunity to take on leadership responsibilities, expand their skill set, tackle larger challenges associated with restoration and maintenance, and receive support and guidance to complete projects that improve the health of public spaces they care about. The Partnership will build on the success of existing volunteer leadership programs, such as the Friends of the Duwamish Hill Preserve and EarthCorps' Puget Sound Stewards program, to build a community of dedicated volunteer leaders across Tukwila. Trained Stewards will work with the Partnership in the following ways:

- Attend regular training events, including a program orientation and more skill-specific training as resources

allow.

- Serve as key contacts for the Green Tukwila Partnership projects in their site.
- Organize and lead volunteer events and activities in their site.
- Coordinate with staff to develop site restoration plans.
- Request tools, materials, and assistance as needed.
- Track and report progress on restoration activities via the Partnership's work log.
- The Partnership will support them with staff time, resources, and guidance in site planning and restoration work.

Community Objective 7: Appreciate volunteers and publicly celebrate Partnership successes

The Green Tukwila Partnership will continue to celebrate volunteers' achievements and emphasize the crucial role they play in restoring and maintaining Tukwila's forested parks and natural areas.

Volunteers are a valuable resource and are crucial for completing on-the-ground Partnership goals. Stewards and volunteers are the very heart and soul of the Green Tukwila Partnership and are valued for their expertise and the rich and diverse perspectives they bring, not only to community engagement, but also on-the-ground stewardship practices. The Partnership will regularly seek the advice of volunteers on which best management practices work well and which may need reassessment. The Green Tukwila Partnership will host volunteer-appreciation activities, such as an annual picnic for Green Tukwila Stewards and volunteer appreciation at community volunteer events. The Partnership seeks to find a variety of ways to recognize Stewards and other volunteers for their valuable efforts.

Community Objective 8: Engage and educate residents and private landowners

While stewardship of public forest and natural areas is an important step toward protecting habitat for wildlife, improving water quality, and providing public recreational opportunities, private properties cover a greater portion of Tukwila's land area. Plantings on private lands can greatly degrade the condition of the city's parklands despite best efforts to restore, maintain, and steward these areas. For instance, English ivy growing as a border plant in a landowner's backyard can quickly escape into a forested or natural-area park either by spreading beyond the property line or by birds dispersing the seeds. Many invasive species also spread when yard waste is illegally dumped in parkland. In fact, these are the most common ways public forest and natural areas become infested with invasive species.

Alternatively, landowners can be a great resource for their neighborhood parkland by engaging their neighbors, schools, community groups, clubs, and businesses to help support the Partnership's efforts. Private land can also be a main source for retaining trees and expanding current forest canopy and

Photo by Nick Krittawat

habitat. Privately owned forest and natural areas in good health can serve as important buffers to adjacent public parklands and help mitigate habitat fragmentation and edge effects.

Potential ways for the Green Tukwila Partnership to educate and engage private landowners as an important constituency include:

- Developing mailings and handouts to inform them about the problems facing forested and natural-area parklands, the benefits of removing invasive species from their properties and replacing them with native or non-invasive ornamental species, and ways to get involved in the Partnership.
- Providing information about the Green Tukwila Partnership's efforts on the Partnership's webpage, in park kiosks, and in neighborhood newsletters and local newspapers.
- Connecting private landowners with programs such as the National Wildlife Federation's Certified Wildlife Habitat or Schoolyard Habitats.
- Training landowners in best management practices through the Green Tukwila Steward Program.
- Continuing to work with other City departments to disseminate a stewardship-friendly plant list for developers and landowners that discourages invasive species and promotes native or noninvasive species and tree retention.

RESOURCES

Financial resources, staff capacity, and volunteer contributions will affect the Green Tukwila Partnership's ability to restore and maintain the 138 acres identified for stewardship in this plan. During the next 20 years (2017–2036), the Partnership will need an estimated $5.73 million in funding (2016 dollar value), as well as volunteer support, to accomplish the proposed goals. The goal of volunteer investment is 71,500 hours over the life of the program. This will leverage an additional value of $2 million as a match to the estimated $5.73 million in direct costs. Volunteer time is valued at $28.99, based on the 2015 Independent Sector valuation of a volunteer hour in Washington State. This is an ambitious plan that relies on additional resources.
As a true partnership there will be many entities involved with direct restoration of land and therefore ensuring that there is sufficient funding available to complete the work under the umbrella of Green Tukwila Partnership. The current property ownership breakdown is illustrated in Table 4. The above cost estimate of $5.73 million includes all lands and it is assumed that each land owner would take on some responsibility for securing funding for their respective sites. Also, while different land owners would help secure funding for their respective sites the initial implementation of the Green Tukwila Partnership will be undertaken by the City of Tukwila Parks and Recreation Department. Therefore, the reminder of this cost discussion focuses on the 88 acres of land owned and managed by the Parks and Recreation Department. The total estimated program cost for these 88 acres of land is $3.47 million.

Ownership	Acres
City of Tukwila	87.57
Tukwila School District	12.43
Seattle City Light	10.91
City of Tukwila, DNR	6.04
City of Tukwila, King County	5.41
WSDOT	3.26
Private ownership	3.25
Highline School District	3.12
King County Parks	3.02
ROW	2.48
Total	**137.49**

Table 4: Land ownership (acres)

Estimating Program Costs

In 2005, the Green Seattle Partnership estimated the costs of restoring 2,500 acres of forested parks for a 20-year period. It relied on estimates of past costs for removing invasive species, replanting, and ongoing maintenance, as well as staff needs and costs associated with additional fieldwork, materials, planning, program design and management, funding development, outreach and marketing, and field and office overhead.

For the Green Tukwila Partnership, we used a cost model

adapted from the Green Seattle Partnership's original estimates (inflated to 2016 dollars), adjusted to reflect the experience of the other Green Cities. Given that Tukwila's park system is much smaller than Seattle's, the Green Tukwila Partnership will require lower overall field costs, fewer staff, and lower overhead. For this plan, all cost estimates and leverage volunteer values are listed in 2016 dollars.

Using a cost model that enrolls a percentage of acres from each tree-iage category each year over 20 years, the average costs per acre going through the four phases of restoration and ongoing maintenance can be calculated (Table 5).

Tree-iage Category	Cost / Acre
1	$22,000
2	$31,200
3	$37,900
4	$27,900
5	$33,500
6	$44,600
7	$31,800
8	$41,700
9	$53,700

Table 5: Average Restoration Cost per acre by tree-iage

For the Green Tukwila Partnership, the model estimates that enrolling all 88 acres in active management will cost from $22,000 per acre for tree-iage category 1 acres to $53,700 per acre for tree-iage category 9 acres. This estimate includes projected program and administrative staff plus field supplies and support, with a built-in 15% overhead on field expenses and 7% overhead on staff time. These costs per tree-iage category are specific for Tukwila and the length of the program; they will need to be adjusted for use in other areas and program durations.

The cost per acre for each tree-iage category is the total estimated cost from the time it is enrolled until the end of the plan in 2036. For example, the model projects enrolling 1.5 new acres in 2017, with a combined first-year program cost of $77,000 for staff, field expenses, and overhead needed. As more new acres are added each year, the cost model accounts for various phases and maintenance of the total accumulation of acres enrolled. The cost model also accounts for a gradual ramping up of acres enrolled per year. New acres enrolled per year would reach a maximum of 8 acres in year 2025, and remain at 8 new acres per year until 2030. At which time a gradual decrease in new acres per year would occur. All 88 acres of land would be enrolled in restoration by the end of 2032. Based on the adjusted estimates, the model forecasts that it will cost approximately $3.47 million in 2016 dollars to implement the Green Tukwila Partnership through 2036 to enroll all City of Tukwila Parks and Recreation Department lands. Although the total is a high number, the cost of effectively managing these lands solely using commercial crews would be more expensive — and more importantly, would not ensure long-term success from community ownership in the program.

Table 6 provides a breakdown of Tree-iage category and cost for the 88 acres of Parks and Recreation lands, and Figure 14 provides a graphic illustration of the costs of the program and volunteer match over the 20-year time period.

The remaining acres and costs are illustrated in the follwing series of Tables 7 through 10, and are broken out by ownership. Table 10 is a summary of all land and costs by Tree-iage.

Tree-iage Category	Acres	Cost / Acre	Total Cost
1	0.14	$22,000	$3,080
2	6.82	$31,200	$212,784
3	4.26	$37,900	$161,454
4	2.98	$27,900	$83,142
5	20.98	$33,500	$702,830
6	38.47	$44,600	$1,715,762
7	5.75	$31,800	$182,850
8	2.70	$41,700	$112,590
9	5.47	$53,700	$293,739
Totals	**87.57**		**$3,468,231**

Table 6: Parks and Recreation land cost summary

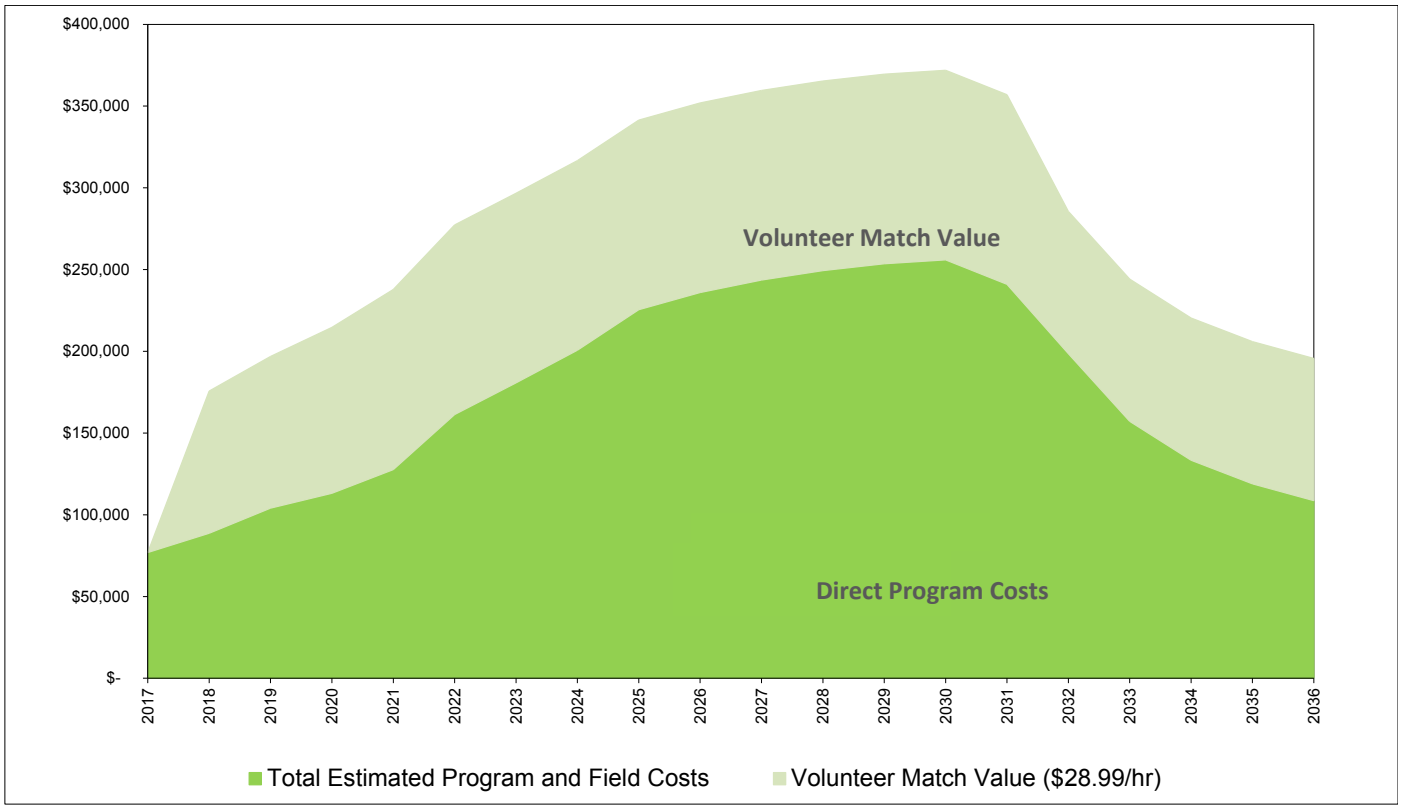


Figure 14: 20-year projections of program costs and volunteer match value

Tree-iage Category	**Acres**	Cost / Acre	Total Cost
1	0.00	$22,000	$0
2	2.57	$31,200	$80,251
3	0.00	$37,900	$0
4	0.00	$27,900	$0
5	1.11	$33,500	$37,115
6	11.50	$44,600	$513,027
7	0.00	$31,800	$0
8	0.00	$41,700	$0
9	2.85	$53,700	$152,822
Totals	**18.03**		**$783,215**

Table 7: School district land and ROW cost summary

Tree-iage Category	Acres	Cost / Acre	Total Cost
1	1.14	$22,000	$24,974
2	0.00	$31,200	$0
3	0.00	$37,900	$0
4	1.25	$27,900	$34,873
5	1.57	$33,500	$52,626
6	0.15	$44,600	$6,827
7	3.89	$31,800	$123,702
8	0.00	$41,700	$0
9	12.44	$53,700	$668,185
Totals	**20.44**		**$911,188**

Table 8: King County, Washington State Dept of Transportation, Seattle City Light and Private Lands

Tree-iage Category	Acres	Cost / Acre	Total Cost
1	0.00	$22,000	$0
2	0.00	$31,200	$0
3	0.00	$37,900	$0
4	0.00	$27,900	$0
5	0.00	$33,500	$0
6	9.42	$44,600	$420,040
7	0.00	$31,800	$0
8	0.00	$41,700	$0
9	2.03	$53,700	$108,836
Totals	**11.44**		**$528,876**

Table 9: Other jointly managed lands cost summary

Tree-iage Category	Acres	Cost / Acre	Total Cost
1	1.27	$22,000	$27,940
2	9.39	$31,200	$293,035
3	4.26	$37,900	$161,454
4	4.23	$27,900	$118,015
5	23.66	$33,500	$792,571
6	59.55	$44,600	$2,655,930
7	9.64	$31,800	$306,552
8	2.70	$41,700	$112,590
9	22.79	$53,700	$1,223,805
Totals	**137.49**		**$5,691,892**

Table 10: All lands cost summary

Resource Objective 1: Continue current City funding and build capacity for future growth

During the program's first five years, the cost model projects an estimated cost of $77,000 in 2017, which grows to $260,000 in 2030 (the highest annual amount). Additional funding sources will need to be secured to bring all 138 acres identified in the forest assessment into restoration by 2036.

Resource Objective 2: Leverage City funds through partnerships and develop long-term funding to support the work

Forterra and EarthCorps are already active partners with the City, working on restoration projects within the Green Tukwila project area. By bringing in additional partners, strengthening partner relationships, and seeking outside funding to support partners working together, City funds will be leveraged to achieve this plan's outcomes.

Resource Objective 3: Provide sufficient staff and resources to support fieldwork, volunteer outreach and management, community engagement, and program administration

Volunteer Management

Currently, volunteers are providing approximately 3,000 hours each year supporting the type of stewardship work in Tukwila's parks and natural areas that the Partnership seeks to expand. While these are not all specific forest-restoration hours, the number serves as a baseline for similar volunteer activity.

The City of Tukwila does not currently have a dedicated volunteer-coordinator position who could manage Green Tukwila volunteers, although it does have staff involved in various relevant positions, including critical-area management, outreach, and community events. As the Green Tukwila Partnership approaches its goal of 4,000 volunteer hours at its peak in 2021, experience suggests that at least one employee will need to be dedicating 1,560 to 2,080 hours annually for managing and coordinating restoration volunteer efforts across the program. This position would track volunteer time, recognize volunteer achievements, and recruit additional volunteers, and could also run the Forest Steward Program, discussed below. Forterra will initially play a major role in volunteer management, conducting regular volunteer events to help incorporate the experience gained through implementing the other Green City Partnerships. As a structure becomes established, the City can take the lead in volunteer management internally or continue to contract these services with a professional provider.

Forest Steward Program Management and Training

At its inception, the Green Tukwila Partnership will already include trained site Stewards supported by Forterra and EarthCorps at several sites within the project area. The Green Tukwila Partnership will continue to recruit and train additional volunteers who are interested in a higher level of commitment than attending occasional staff-led volunteer events. These Stewards will allow the Partnership to increase community leadership on the ground and therefore its capacity to reach more restoration sites. Stewards will lead volunteer events, create work plans, track restoration progress, and apply for small grants to manage their sites. This program will also keep regular volunteers interested by providing a challenging and diverse array of work, and increased ownership of the results.

The success of the Steward Program is dependent upon a staff member being able to coordinate the program, including training new stewards, working with them to develop site plans, providing support and encouragement, coordinating their efforts with other city staff, and keeping track of their accomplishments in relation to Partnership goals. These duties are estimated to take 520 to 1,040 hours annually. For consistency in program implementation and volunteer support, it is strongly recommended this role be incorporated into the duties of the volunteer coordinator mentioned above.

Outreach and Education

Staff time devoted to education and outreach will be critical in helping increase volunteer capacity to 4,000 hours by 2021 and hosting many appreciation and public-engagement events each year. Reaching the broader Tukwila public will require a staff person to devote a portion of time to Green Tukwila Partnership outreach and education. Forterra can help fill some of this role during the program's first year, or longer as needed and if resources allow. The City will also

coordinate with the Communications Manager, within the Mayor's Office, to take advantage of outreach opportunities that exist through its publications and products.

Communications and marketing are linked to the duties of volunteer management, outreach, and education. This work will be started by Forterra for the first two years of the program and includes creating and implementing a communications and marketing plan. This will help the Partnership increase visibility and recruit volunteers, as well as increase the potential for generating additional program funding by reaching a wider audience.

Field Restoration

Current City of Tukwila staffing alone cannot meet the management needs of restoring and maintaining all 138 acres by 2036. Through the Green Tukwila Partnership, partner agencies and community leadership will play a major role in filling the gap. Planning and Urban Environmental Specialist staff will continue to play a lead role in evaluating and managing Tukwila's forested parks and natural areas, especially as more volunteers are brought in to help restoration work. Besides these staff members, the Parks and Recreation Department may contract with skilled field crews for some fieldwork on sites that are not appropriate for volunteers, and partner agencies will either use their own crews or contract as well. In the first couple of years, training in restoration best management practices and volunteer management will help ensure that all staff and contractors are up to speed with the same techniques and approach that are being taught to forest stewards, in addition to crew-specific practices that volunteers are not permitted to perform. This coordination will be one of the functions of the Green Tukwila Management Team.

Program Administration and Fund Development

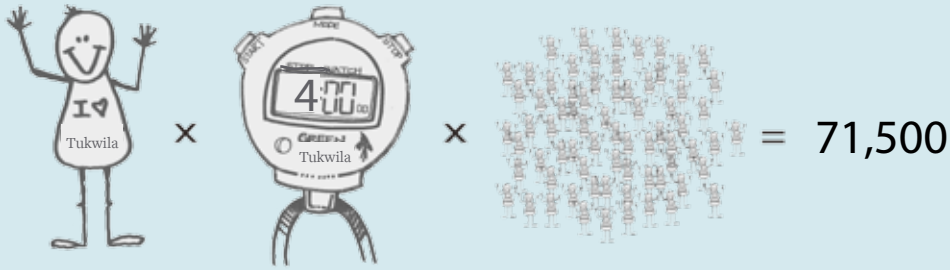
Designated City staff will be needed to oversee and administer the program. This includes establishing annual program work plans and communicating with various City commissions and City Council so they remain informed about the programs success and any challenges along the way. This also includes development and management of funding. Stable funding is crucial to supporting the Partnership's efforts. The role may be large if many small funding sources are compiled, or less intensive if funding is derived from one or a few larger sources. This role may incorporate grant writing.

Resource Objective 4: Coordinate efforts by partner staff and volunteers to maximize joint success and share resource

Working across ownership boundaries, partner agencies — including both landowners such as the City of Tukwila and

Everyone Pitching In

If every Tukwila resident contributed just a bit more than 4 hours, we would achieve our goal of restoring and maintaining Tukwila's forested parks and natural areas and open spaces. That's just one work party during the program's 20 years. Many hands make light work!



Seattle City Light, and partners such as Forterra, EarthCorps, and others helping to implement the work outlined in this plan — will need to work together. All partners will need to communicate and coordinate their efforts so the work on the ground and in the community is conducted in a way that addresses needs in a comprehensive, rather than piecemeal, manner. In order to take advantage of opportunities to share resources and avoid duplicating efforts, all active partners will meet regularly as a Management Team. The Management Team will hold quarterly meetings in the first year of the Partnership, and may meet more often and/or form committees to address certain topics as the Partnership grows. The Management Team will also be in communication with other relevant local groups, such as the Duwamish Alive Coalition, Green River Coalition, and Green Cities Network.

Resource Objective 5: Deploy skilled field crews as appropriate, prioritizing training crews and job-skills-development programs available to Tukwila residents

Professional crews will be needed for priority sites that lack sufficient volunteer support or sites with difficult conditions that are unsafe or otherwise inappropriate for volunteers. Some sites containing extreme invasive plant infestations, steep slopes, riparian areas, and wetlands may be better suited to skilled field crews.

The Partnership will seek to contract with organizations that focus on forest-habitat management, and will prioritize those that provide training and job-skills development to local residents, especially youth. The following activities will support this objective:

- City and partner staff will continue to work on key management efforts, volunteer support, and training for Stewards to increase community capacity.
- Nonprofit and training crews (such as Washington Conservation Corps, Student Conservation Association, EarthCorps, Duwamish Valley Youth Corps, and DIRT Corps) will have priority to be hired, as needed, for fieldwork at difficult sites and occasionally for volunteer management at large events, given their expertise. Crews that offer jobs and job training to Tukwila residents will be further prioritized.
- Private landscaping and habitat-restoration companies (commercial crews) will be hired for highly technical projects as budget and need dictate.

Resource Objective 6: Increase volunteer engagement to leverage support from the community

Over 20 years, our goal is for volunteers to provide more than 71,500 hours, valued at $2 million, based on the 2015 Independent Sector valuation of a volunteer hour at $28.99 in Washington State. To put this number in perspective, if every Tukwila resident contributed just four hours during the entire 20-year program, the plan would achieve its community-engagement goals. If every resident contributed just

Photo by McRob

Photo by McRob

eight hours over the entire 20-year program, the Partnership would double its goals and leverage significantly more toward restoration and management of Tukwila's parks and natural open space.

To meet the needs of all volunteers, the Green Tukwila Partnership will provide several ways in which they can participate. A variety of large volunteer events can be held in conjunction with community groups and businesses. Community events aimed at promoting more of a connection between local residents and their urban environment will hopefully encourage more people to take an interest in stewardship efforts. The Steward Program can support community leaders in developing and coordinating regular work parties that volunteers can attend as often as they wish. Active management at these sites will range from large invasive-plant-removal projects and planting native species to monitoring past restoration.

Increased levels of volunteerism will be encouraged. Volunteers who participate in one-day events with a business or community group will be invited to continue their participation in ongoing work parties. Frequent volunteers may be interested in becoming Stewards so as to increase their involvement. To do this, there will be a need to keep existing volunteers motivated by showing them how their efforts, in concert with those of many other volunteers, have a significant impact in maintaining and restoring Tukwila's forested parks.

The Partnership provides opportunities for individuals of varying physical ability and time commitment to get involved. There are numerous volunteer activities for those who are uninterested or unable to participate in physical fieldwork, or who require a more flexible schedule, including photography, database and administrative work, publicity and marketing, fund-raising, sponsor recruitment, community event support, and bringing snacks and beverages to work parties.

In addition to encouraging current volunteers, new volunteers can be recruited through community outreach that emphasizes their critical need and the important role they play in effective management. Partnerships with community, youth groups, businesses, and schools can also be used to introduce new volunteers to the program.

Diversity within the Partnership will strengthen work efforts and build community. An important component of outreach efforts will involve contacting communities that have not traditionally participated in environmental restoration or stewardship. Outreach to these communities can be increased by working with local groups, youth organizations, schools, and businesses, looking for ways to collaborate on projects that offer mutual benefit and culturally relevant ways to participate. Informational signs at park sites can be posted describing the work under way and inviting participation. The existing partnership between the City of Tukwila and the Tukwila School District can be strengthened to provide opportunities for students who want to complete community-service requirements for graduation, and participate in restoration projects on school grounds within the Green Tukwila project area.

Resource Objective 7: Support local businesses

The work of the Green Tukwila Partnership offers many opportunities to support the Tukwila economy and local businesses within the city in the following capacities:

- Professional field crews for on-the-ground restoration and stewardship
- Local businesses to provide food and refreshments for volunteer and other community events
- Graphic designers, marketing and outreach specialists, and other professionals to help with promotion of Partnership activities
- Photographers to help document events
- Skilled professionals to offer training to staff and volunteers in a wide variety of topics, from plant identification and ecology to ethnobotany, community engagement, and grant-writing
- Engagement opportunities, including corporate donations and volunteering, for businesses to get their name out in front of the community and offer team-building activities.

VI. ADAPTIVE MANAGEMENT

The Green Tukwila Partnership's primary goal is to reestablish and maintain healthy, sustainable natural open spaces. The Partnership is an intensive, one-time intervention to restore the health of Tukwila's native habitats through community action, volunteer effort, and strategic restoration planning. After 20 years and restoration of the projected 138 acres in the program, labor and funding needs can be reduced to a maintenance level, but funding needs will continue to exist. The goal of a healthy natural forest or natural-area park can be achieved only by careful management of resources.

Photo by McRob

Urban forests and public natural areas are complex ecosystems influenced both by natural factors and the human systems that surround them. These human systems that impact and ultimately must care for these ecosystems are equally complex. Any strategy to restore and maintain forested parklands must systematically address all the factors that affect the health of those lands. In response to this complexity, an adaptive management model has been developed.

Adaptive management systematically improves management policies and practices. It is a repeating cycle of six steps: problem assessment, strategy development, implementation, monitoring, evaluation, and strategy adjustment (see Figure 15). Once an evaluation is complete, new information gathered from monitoring is used to reassess the problem and develop new strategies as needed. Then implementation, monitoring, and evaluation occur, and the cycle begins again.

This section describes how the Partnership will apply adaptive management and the Balanced Scorecard approach to track and monitor progress, distribute resources, and report on the Partnership's success. The Balanced Scorecard approach to strategy development and monitoring helps assess all aspects of the program (fieldwork, community, and resources) necessary to reach the goal of enrolling all 138 acres in restoration by the end of 2036. Simply monitoring the outcomes of fieldwork would not allow staff to anticipate problems and make adjustments to other parts of the program. The Balanced Scorecard allows staff to track the resources and community support necessary for accomplishing the fieldwork.

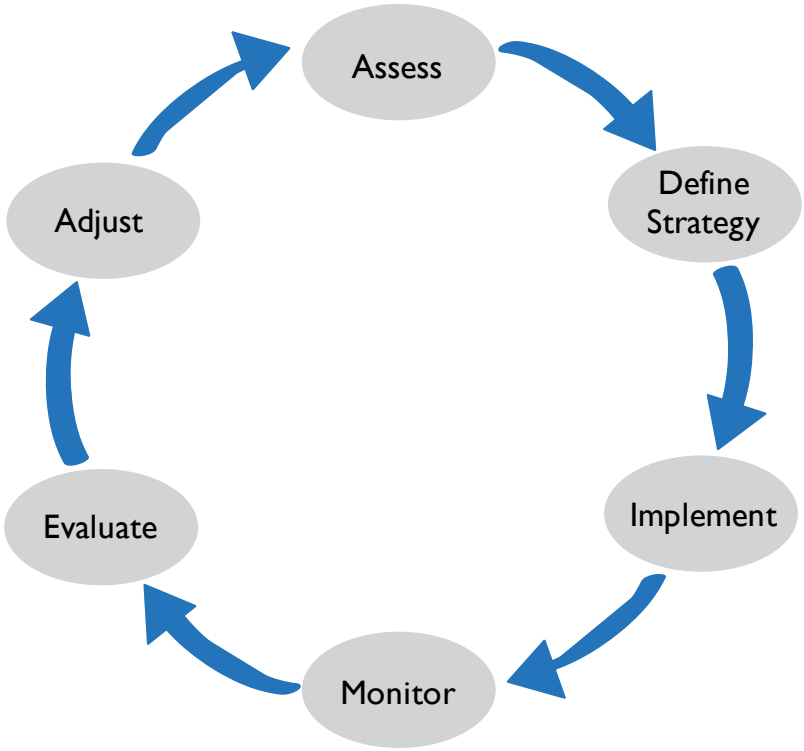


Figure 15. Adaptive management framework cycle

MEASURING SUCCESS

Two types of information will help in analyzing the Green Tukwila Partnership's effectiveness: program monitoring and field monitoring. Monitoring allows for improvement in Partnership program design and performance by measuring the effectiveness of strategies and techniques used. The results of monitoring are fed back into Partnership planning and methodology to increase effectiveness. Monitoring and evaluation will also provide accountability to funding sources and supporters, and help ensure that goals and benchmarks (see Appendix J) are met.

Table 11, page 62 illustrates the Balanced Scorecard for the four primary program elements of implementing the 20-year plan: fieldwork, community, resources, and administration. By measuring progress toward each objective, one can assess the effectiveness of the strategies described in the Implementation section. The effectiveness of program strategies needs to be tracked throughout the life of the plan, and, through adaptive management, adjustments made when necessary.

Photo by McRob

PROGRAM EVALUATION

At the close of each year, Green Tukwila Partnership staff will continue to collect data on Balanced Scorecard measures and track progress toward the annual work-plan goals and benchmarks. Data-management systems will be developed to record information pertinent to these measurements throughout the year so that progress can easily be summarized at year's end.

Photo by McRob

FIELD MONITORING

As the restoration and maintenance program proceeds, routine monitoring of restoration sites will continue to be conducted to track the condition and health of restored sites and gauge progress. Success will rely on developing and refining effective strategies to remove and control invasive plants.

To monitor fieldwork, new acres will be tracked as they are brought into active restoration and mapped in GIS. Volunteer and skilled-field-crew time will be devoted to revisiting sites that have been previously worked on and assessing their ongoing needs as they move through the four phases of restoration. One component of monitoring is to track plant survival rates. Plant-survivorship thresholds are outlined in site-level stewardship plans and may vary depending on site conditions or habitat type. These forests and natural areas will always be subject to pressure from their surroundings. Although the work needed decreases dramatically each year that an area goes through the program, Phase 4 of restoration continues indefinitely.

As the Partnership enrolls more acres in restoration, tracking can become complicated. Managing data entry and paperwork as the program grows has proven to be expensive in other Green Cities. The Partnership is in the process of addressing this issue and investigating database tools to streamline data-management processes.

RESOURCE DISTRIBUTION

It is assumed that Green Tukwila Partnership funding will continue to be housed entirely within currently active partners — the City of Tukwila, Forterra, and EarthCorps — for at least the first year of the program. After that, staff from the City and partner organization will continue to oversee program funding and work toward generating additional funding (both from City and non-City sources) and donations from outside sources throughout the duration of the Partnership's 20-year span. The Partnership will allocate funds for the three program areas — community, fieldwork, and resources — in proportions that will change during the course of time to help ensure that the program's basic goals are achieved. As it grows from single-site efforts to a systemwide program, the emphasis will shift from funding program development to fieldwork support.

At the front end, resources will be directed toward recruiting and supporting Stewards, along with demonstrating on-the-ground results and success in the field, and hosting highly visible community events that foster engagement with Green Tukwila sites. These activities will ramp up during the first five years (2017–2021) as volunteer efforts grow. Once a strong volunteer program is established, some resources can shift to provide more field support for restoration projects.

As funding allows in the future, the field-management budget can expand from funding Partnership staff time and supporting volunteers to include additional skilled field crews. Implementation tools such as BMPs will be incorporated into their work.

As visibility and recognition increase, increased levels of public and private funding can materialize and support increased volunteer participation. The role of volunteers will continue beyond 2036, since parks and natural areas will need ongoing volunteer support and stewardship.

REPORTING AND KNOWLEDGE SHARING

The Green Tukwila Partnership's progress will be reported annually to the Tukwila City Council, Tukwila Parks Commission, partners, Stewards, volunteers, and the public. Annual work plans will be adjusted in response to available funding, monitoring results, and emerging knowledge of successful restoration techniques.

Partnership staff will utilize creative outreach strategies, and network with regional restoration groups, which will provide an opportunity for staff to share information and learn from other agencies. As a member of the Green Cities Network, the Green Tukwila Partnership will have opportunities to share successes and challenges with other cities (Seattle, Tacoma, Kirkland, Redmond, Kent, Everett, Snoqualmie and Puyallup) that are dedicated to a similar goal and vision. Written materials, including this 20-year plan, will be posted on the Green Tukwila Partnership website (www.greentukwila.org), and all parties using these resources will be given the opportunity to provide feedback on the Partnership's methods and materials.

Table 11. Balanced Scorecard

OBJECTIVE		MEASURE
Restore and maintain 138 acres of parks and natural areas by 2036		# of acres in restoration to annual goal
FIELDWORK: All 138 acres are restored by 2036		
Evaluate	Evaluate conditions and prioritize sites for restoration using tree-iage model	# sites evaluated, prioritized
Plan	Develop annual work plan for each active Park	Annual work plan completed identifying active management sites at each active Park
Implement	Implement restoration projects optimizing ecological function, using the 4-phase approach	• # of acres entered into active management • Best practices evaluated annually and updated as needed
Monitor	• Establish monitoring program • Monitor and maintain sites over the long term	• Annual monitoring report • # of acres entered into Phase-4 work • Maintenance is performed as indicated
COMMUNITY: An informed, involved, and active civic community supports the Green Tukwila Partnership.		
Residents	Educate and engage community about problem and solution through Green Tukwila Partnership	Outreach and education program materials developed and distributed
	Community supports and desires active management of forested parklands through widespread understanding of the issue and support of the Partnership as a solution	• % of residents volunteering each year • # of return volunteers
	Encourage businesses to contribute to program goals	• # of businesses supporting program through sponsorship, in-kind contributions, or volunteer events • # of businesses supporting volunteer events
Volunteers	Engage youth and community organizations in restoration and monitoring	• # of groups participating in events • # of hours contributed
	Recruit and train forest stewards in volunteer management and BMPs	• # of active forest stewards • # of forest steward events
	Demonstrate appreciation for volunteers and seek input into program	• # of volunteer suggestions implemented • # of volunteer recognition activities
RESOURCES: Sufficient resources are available to actively manage sites and provide long-term maintenance.		
Financial	Continue current municipal funding	$ budgeted and sourced to meet management requirements
	Develop long-term, stable public funding source	Mechanisms in place by 2027 sufficient to meet need
Paid Staff & Labor	Provide sufficient staff to support fieldwork, volunteer management, and Partnership programs	• # staff/crew dedicated to supporting the program • % of requests for crew/staff assistance completed
	Deploy skilled field crews for priority sites lacking volunteer support or sites with difficult conditions	• # of acres in restoration due to crew/staff • % of skilled field crews trained in BMPs
Volunteer Labor	• Increase number of individual volunteers as well as the overall number of volunteers • Increase productivity by providing support and materials to volunteers	• # of hours to annual goal • Estimated value of volunteer contribution • $ and hours/acre enrolled • Staff cost per volunteer hour • # of tool/material requests processed

VII. REFERENCES

American Forests. 1998. Regional Ecosystem Analysis of Puget Sound Metropolitan Area. Final Report 7/25/1998. Washington, D.C.: American Forests.

American Forests. 2001. Urban Ecosystem Analysis Atlanta Metro Area: Calculating the Value of Nature. Washington, D.C.: American Forests. arboretum.agnesscott.edu/tree-walk/learn-more/american-forests-urban-ecosystem-analysis-atlanta, accessed September 3, 2016.

Boersma, P. D., S. H. Reichard, and A. N. Van Buren, eds. 2006. Invasive Species in the Pacific Northwest. Seattle: University of Washington Press.

Brabec, E., P. Richards, and S. Schulte. 2000. "Fragmentation, Impervious Surfaces and Water Quality: Quantifying the Effects of Density and Spatial Arrangement." Fragmentation and Land Use Planning: Analysis and Beyond Proceedings Vol. Third International Workshop on Sustainable Land Use Planning works.bepress.com/cgi/viewcontent.cgi?article=1013&context=elizabeth_brabec, accessed May 11, 2015.

Brown, B., D. D. Perkins, and G. Brown. 2003. "Place Attachment in a Revitalizing Neighborhood: Individual and Block Levels of Analysis." Journal of Environmental Psychology 23:259–71.

Brunson, L. "Resident Appropriation of Defensible Space in Public Housing: Implications for Safety and Community." (PhD dissertation, University of Illinois at Urbana-Champaign, 1999).

California Department of Forestry and Fire Protection. 2011. "Urban & Community Forestry at a Glance." wrrc.arizona.edu/sites/wrrc.arizona.edu/files/UrbanForesty_factsheet_print2011.pdf, accessed September 3, 2016.

Ciecko, L., D. Kimmett, J. Saunders, R. Katz, K. L. Wolf, O. Bazinet, J. Richardson, and D. J. Blahna. 2016. Forest Landscape Assessment Tool (FLAT): Rapid Assessment for Land Management. General Technical Report TBD. Portland, OR: US Department of Agriculture, USDA Forest Service, Pacific Northwest Research Station.

City of Tukwila. 2015. Comprehensive Plan. http://www.tukwilawa.gov/wp-content/uploads/DCD-Comprehensive-Plan.pdf. accessed February 2, 2017.

Donovan, G. H. and D. T. Butry. 2010. "Trees in the City: Valuing Street Trees in Portland,Oregon." Landscape and Urban Planning 94: 77–83.

Dwyer, J. F., E. G. McPherson, H. W. Schroeder, and R. A. Rowntree. 1992. "Assessing the Benefits and Costs of the Urban Forest." Journal of Arboriculture 18(5): 227–34.

Ellaway, A., S. Macintyre, and X. Bonnefoy. 2005. "Graffiti, Greenery, and Obesity in Adults: Secondary Analysis of European Cross Sectional Survey." British Medical Journal 331: 611–12.

Environmental Protection Agency Office of Transportation and Air Quality. 2014. Greenhouse Gas Emissions from a Typical Passenger Vehicle. (EPA-420-F-14-040a) www.epa.gov/otaq/climate/measuring.htm, accessed September 3, 2016.

Fazio, James R. "How Trees Can Retain Stormwater Runoff." 2012. Tree City USA Bulletin 55.

Arbor Day Foundation. http://docplayer.net/18613997-How-trees-can-retain-stormwater-runoff.html, accessed September 3, 2016.

Foster, J., A. Lowe, and S. Winkelman. 2011. The Value of Green Infrastructure for Urban Climate Adaptation. Washington, DC: Center for Clean Air Policy. ccap.org/resource/the-value-of-green-infrastructure-for-urban-climate-adaptation, accessed September 3, 2016.

Giles-Corti, B., M. H. Broomhall, M. Knuiman, C. Collins, K. Douglas, K. Ng, A. Lange, and R. J. Donovan. 2005. "Increasing Walking: How Important Is Distance to, Attractiveness, and Size of Public Open Space?" American Journal of Preventive Medicine 28: 169–76.

Haack, R. A., F. Herard, J. Sun, and J. J. Turgeon. 2010. "Managing Invasive Populations of Asian Longhorned Beetle and Citrus Longhorned Beetle: A Worldwide Perspective." Annual Review of Entomology 55: 521–46.

Hartig, T., M. Mang, and G. W. Evans. 1991. "Restorative Effects of Natural Environment Experiences." Environment and Behavior 23, 1: 3–26.

Heerwagen, J. H., and G. H. Orians. 2002. "The Ecological World of Children" in Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations. P. H. Kahn and S.R. Kellert, eds. MIT Press, Cambridge, MA. 29–64.

Herms, D. A., D. G. McCullough, D. R. Smitley, C. S. Sadof, and W. Cranshaw. 2014. Insecticide Options for Protecting Ash Trees from Emerald Ash Borer. North Central IPM Center Bulletin. 2nd Edition. extension.entm.purdue.edu/EAB/PDF/NC-IPM.pdf, accessed September 3, 2016.

Herrington, L. P. 1974. "Trees and Acoustics in Urban Areas." Journal of Forestry 72(8):462–65.

Isenberg, J. P., and N. Quisenberry. 2002. "Play: Essential for All Children." Association for Childhood Education International. Childhood Education 79(1): 33–39.

Kaplan, S. 1995. "The Restorative Benefits of Nature: Toward An Integrative Framework." Journal of Environmental Psychology 15, 3: 169–82.

Kim, S., U. Chung, J. J. Lawler, and R. E. Anderson. 2012. "Assessing the Impacts of Climate Change on Urban Forests in the Puget Sound Region: Climate Suitability Analysis for Tree Species." School of Environmental and Forest Sciences, College of the Environment, University of Washington. greenseattle.org/wp-content/uploads/2015/08/Climate-Change-Final-Report.pdf, accessed September 3, 2016.

Kuo, F. E., and W. C. Sullivan. 2001. "Aggression and Violence in the Inner City: Effects of Environment Via Mental Fatigue." Environment and Behavior 33(4): 543–71.

Littell, J. S., M. McGuire Elsner, L. C. Whitely Binder, and A. K. Snover (eds). 2009. "The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate - Executive Summary." In The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. Seattle: Climate Impacts Group, University of Washington. http://www.cses.washington.edu/db/pdf/wacciaexecsummary638.pdf, accessed September 3, 2016.

Littell, J. S., E. E. Oneil, D. McKenzie, J. A. Hicke, J. A. Lutz, R. A. Norheim, and M. M. Elsner. 2010. "Forest ecoystems, disturbance, and climatic change in Washington State, USA." Climatic Change 102: 129–158.

Logvasi, G. S., J. W. Quinn, K. M. Neckermann, M. S. Perzanowski, and A. Rundle. 2008. "Children Living in Areas with More Trees Have a Lower Prevalence of Asthma." Journal of Epidemiology and Community Health (62): 647–49.

Maas, J., R. A. Verheij, P. P. Groenewegen, S. de Vries, and P. Spreeuwenberg. 2006. "Green Space, Urbanity, and Health: How Strong Is the Relation?" Journal of Epidemiology and Community Health 60: 587–92.

Marzluff, J. 2000. Make Your Land More Appealing to Wild Birds: Maintain Native Plants! Seattle: University of Washington, College of Forest Resources Fact Sheet #10, Wildlife Science Program. www.urbanforestrysouth.org/resources/library/ttresources/make-your-land-more-appealing-to-wild-birds-maintain-native-plants, accessed September 3, 2016.

McPherson, E. G., and J. Muchnick. 2005. "Effects of Street Tree Shade on Asphalt Concrete Pavement Performance." Journal of Arboriculture 31(6): 303-10. http://www.fs.fed.us/psw/publications/mcpherson/psw_2005_mcpherson001_joa_1105.pdf, accessed October 1, 2016.

McPherson, E. G., D. J. Nowak, and R. A. Rowntree. 1994. Chicago's Urban Forest Ecosystem: Results of the Chicago Urban Forest Climate Project. General Technical Report NE-186. Radnor, PA: U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. www.nrs.fs.fed.us/pubs/gtr/gtr_ne186.pdf, accessed September 3, 2016.

McPherson, E. G., J. Simpson, P. Peper, Q. Xiao, D. Pettinger, and D. Hodel. 2001. Tree Guidelines for Inland Empire Communities. Rep. Western Center for Urban Forest Research and Education, USDA Forest Service, Pacific Southwest Research Station. https://www.itreetools.org/streets/resources/Streets_CTG/CUFR_52_Inland_Empire_CTG.pdf, accessed September 3, 2016.

Nowak, D.J. 2002. The Effects of Urban Trees on Air Quality. USDA Forest Service, Syracuse, NY. http://www.nrs.fs.fed.us/units/urban/local-resources/downloads/tree_air_qual.pdf, accessed October 1, 2016.

Nowak, D. J., and D. E. Crane. 2002. "Carbon Storage and Sequestration by Urban Trees in the USA." Environmental Pollution 116: 381–89. http://www.fs.usda.gov/ccrc/sites/default/files/Nowak_urban_C_seq.pdf, accessed October 2016.

Nowak, D. J., D. E. Crane, J. C. Stevens, and M. Ibarra. 2002. Brooklyn's Urban Forest. USDA Forest Service Northeastern Research Station General Technical Report, NE-290. www.nrs.fs.fed.us/pubs/5939, accessed September 3, 2016.

Osborne, L. L., and D. A. Kovacic. 1993. "Riparian Vegetated Buffer Strips in Water-quality Restoration and Stream Management." Freshwater Biology 29: 243–58.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. "Environmental and Economic Costs of Nonindigenous Species in the United States." BioScience 50(1): 53–65.

Prince George's County, Maryland, Environmental Services Division, Department of Environmental Resources. Bioretention Manual. 2007.

Ruiz-Jaén, M. C., and T. M. Aide. 2006. "An Integrated Approach for Measuring Urban Forest Restoration Success." Urban Forestry & Urban Greening 4: 55–68.

Schroeder, H. W. 1989. "Environment, Behavior, and Design Research on Urban Forests," in Advances in Environment, Behavior, and Design, E. H. Zube and G. T. Moore, eds. New York: Plenum.

Smithwick, E. A. H., M. E. Harmon, S. M. Remillard, S. A. Acker, and J. F. Franklin. 2002. "Potential Upper Bounds of Carbon Stores in Forests of the Pacific Northwest." Ecological Applications 12(5): 1303–17.

Soule, M. E. 1991. "Conservation: Tactics for a Constant Crisis." Science 253: 744–50.

Sullivan, W. C. , F. E. Kuo, and S. F. DePooter. 2004. "The Fruit of Urban Nature: Vital Neighborhood Spaces." Environment and Behavior 36, 5: 678–700.

Taylor, A. F., F. E. Kuo, and W. C. Sullivan. 2001. "Coping with ADD: The Surprising Connection to Green Play Settings." Environment and Behavior 33(1): 54-77.

Taylor, D. E. 2014. "The State of Diversity in Environmental Organizations." Ann Arbor, Michigan: University of Michigan. Green 2.0.

Tyrväinen, L. and A. Miettinen. 2000. "Property Prices and Urban Forest Amenities." Journal of Environmental Economics and Management 39: 205–23.

University of Washington Center for Urban Horticulture. Urban Forest Values: Economic Benefits of Trees in Cities. 1998. www.naturewithin.info/Policy/EconBens-FS3.pdf, accessed September 3, 2016.

USDA National Agroforestry Center. "Is Agroforestry a Solution to the Southeast's Poultry Overload?" Inside Agroforestry 1998. http://nac.unl.edu/documents/insideagroforestry/1998spring.pdf, accessed September 3, 2016.

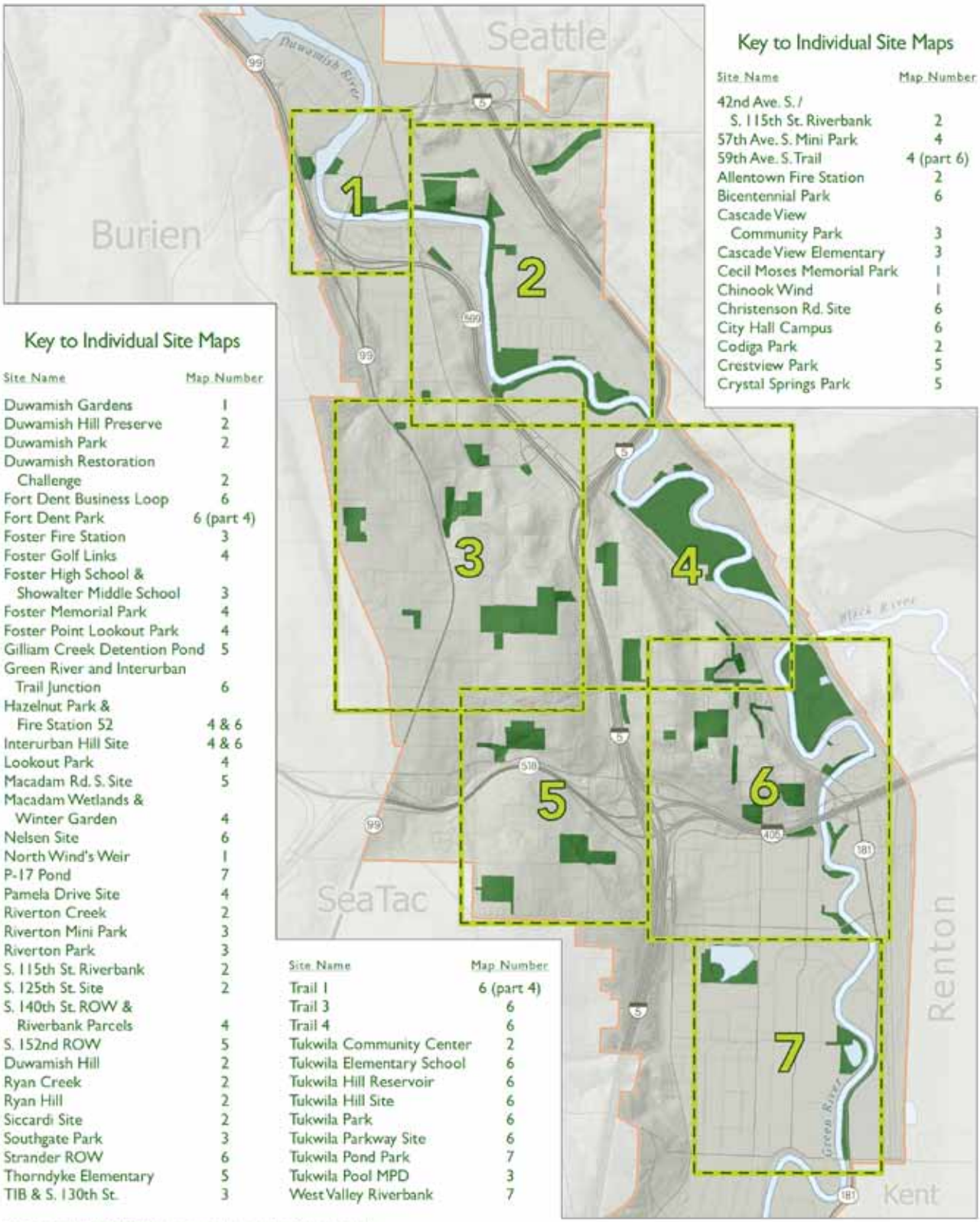
US Department of Health and Human Services. 1999. Physical Activity and Health: A Report of the Surgeon General. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Atlanta GA.

World Health Organization. 2010. "Global Recommendations on Physical Activity for Health." www.who.int/dietphysicalactivity/factsheet_recommendations/en, accessed September 3, 2016.

Xiao, Q., E. G. McPherson, J. R. Simpson, and S. L. Ustin. 1998. "Rainfall Interception by Sacramento's Urban Forest." Journal of Arboriculture 24(4): 235–44.

VIII. APPENDICES

APPENDIX A. MAPS OF TREE-IAGE CATEGORIES PER SITE: OVERVIEW AND INDIVIDUAL SITE MAPS



Key to Individual Site Maps

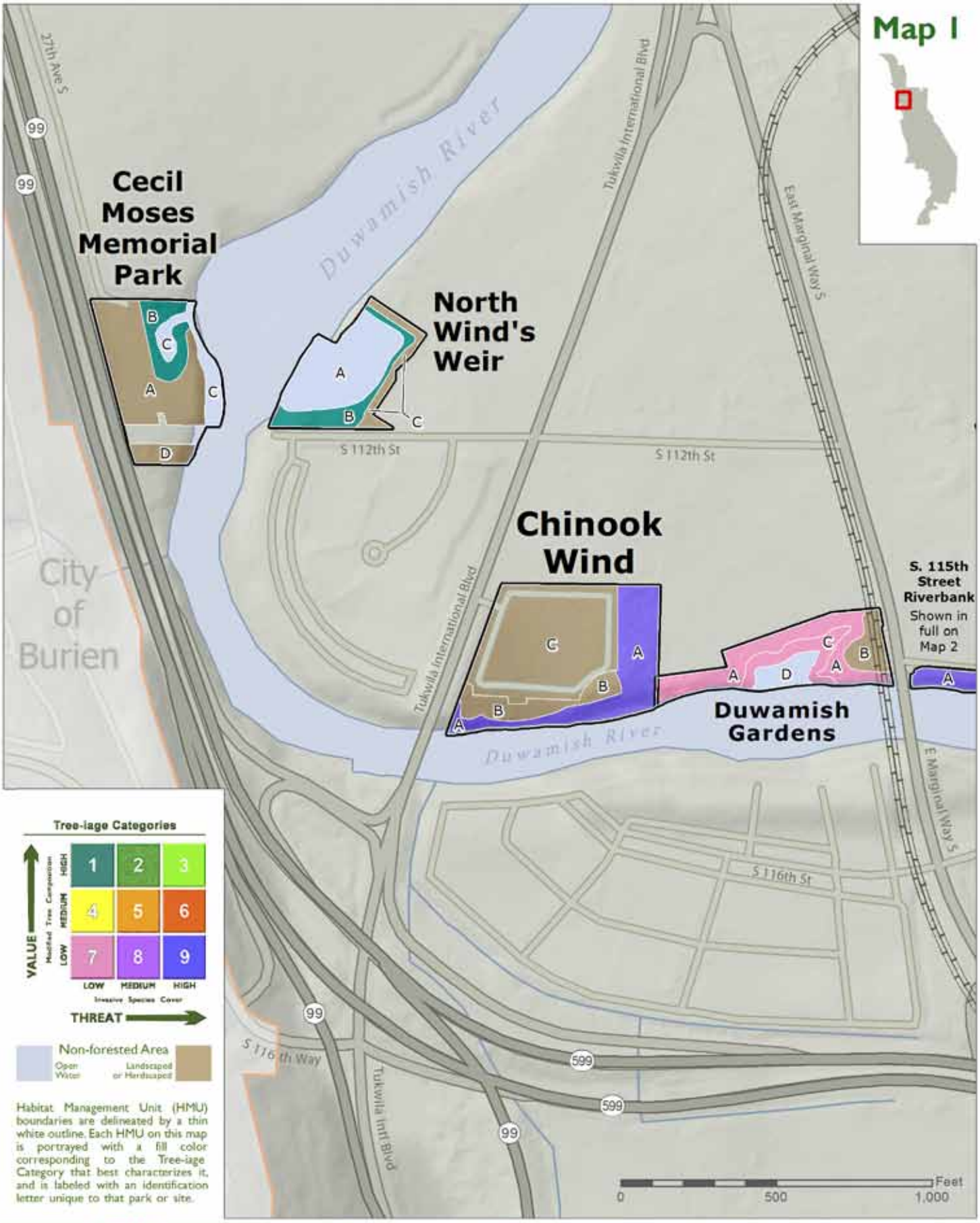
Site Name	Map Number
42nd Ave. S. / S. 115th St. Riverbank	2
57th Ave. S. Mini Park	4
59th Ave. S. Trail	4 (part 6)
Allentown Fire Station	2
Bicentennial Park	6
Cascade View Community Park	3
Cascade View Elementary	3
Cecil Moses Memorial Park	1
Chinook Wind	1
Christenson Rd. Site	6
City Hall Campus	6
Codiga Park	2
Crestview Park	5
Crystal Springs Park	5

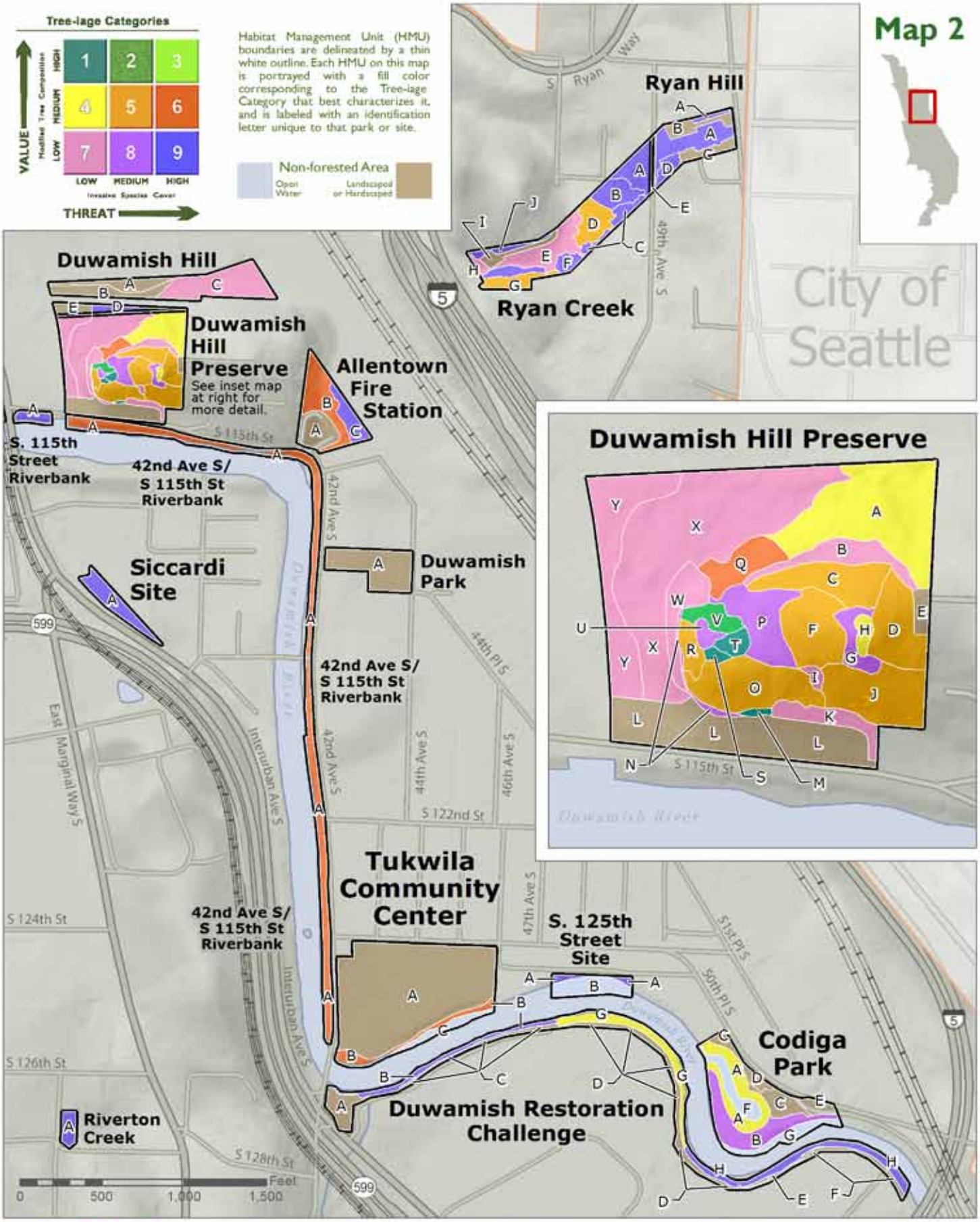
Key to Individual Site Maps

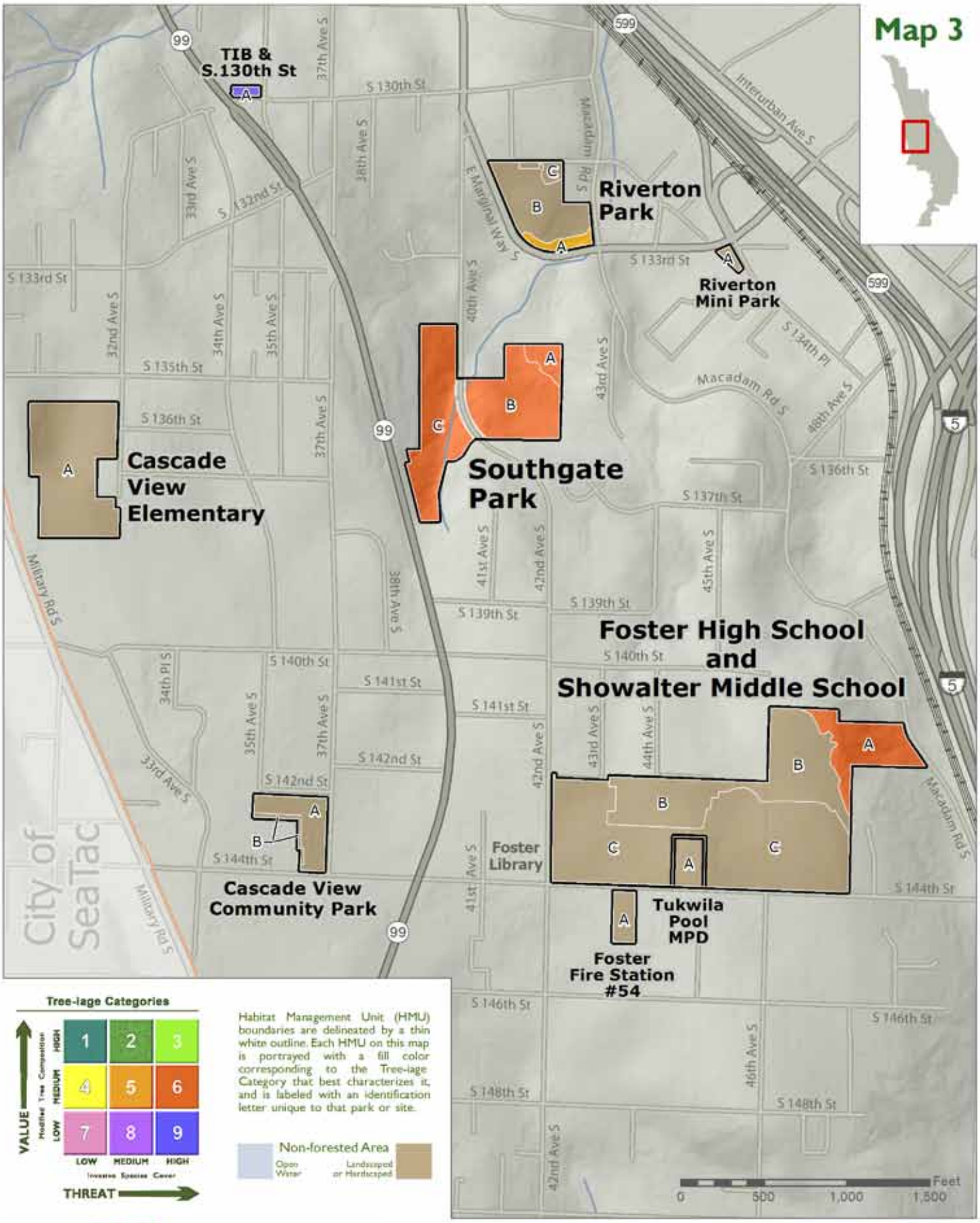
Site Name	Map Number
Duwamish Gardens	1
Duwamish Hill Preserve	2
Duwamish Park	2
Duwamish Restoration Challenge	2
Fort Dent Business Loop	6
Fort Dent Park	6 (part 4)
Foster Fire Station	3
Foster Golf Links	4
Foster High School & Showalter Middle School	3
Foster Memorial Park	4
Foster Point Lookout Park	4
Gilliam Creek Detention Pond	5
Green River and Interurban Trail Junction	6
Hazelnut Park & Fire Station 52	4 & 6
Interurban Hill Site	4 & 6
Lookout Park	4
Macadam Rd. S. Site	5
Macadam Wetlands & Winter Garden	4
Nelsen Site	6
North Wind's Weir	1
P-17 Pond	7
Pamela Drive Site	4
Riverton Creek	2
Riverton Mini Park	3
Riverton Park	3
S. 115th St. Riverbank	2
S. 125th St. Site	2
S. 140th St. ROW & Riverbank Parcels	4
S. 152nd ROW	5
Duwamish Hill	2
Ryan Creek	2
Ryan Hill	2
Siccardi Site	2
Southgate Park	3
Strander ROW	6
Thorndyke Elementary	5
TIB & S. 130th St.	3

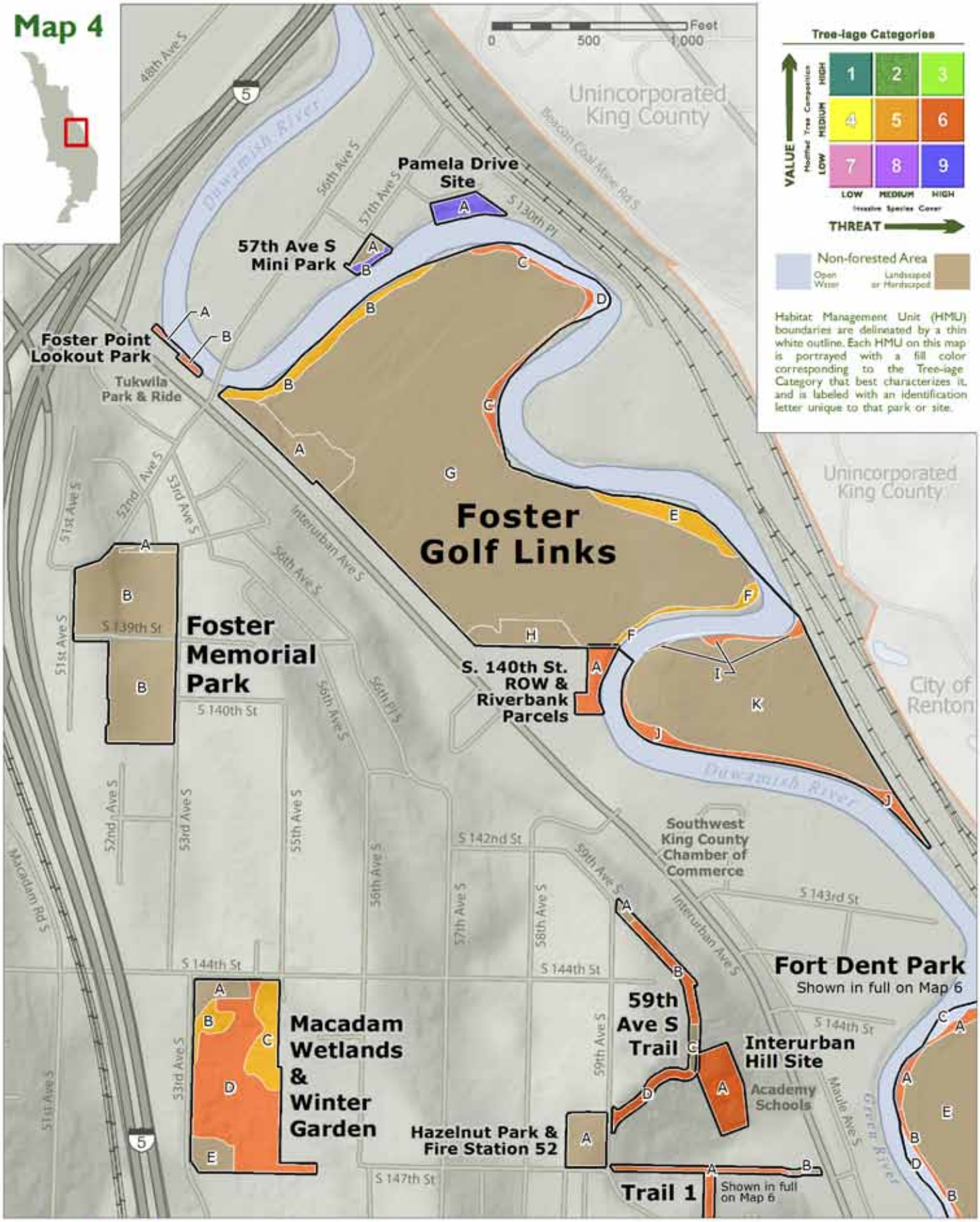
Site Name	Map Number
Trail 1	6 (part 4)
Trail 3	6
Trail 4	6
Tukwila Community Center	2
Tukwila Elementary School	6
Tukwila Hill Reservoir	6
Tukwila Hill Site	6
Tukwila Park	6
Tukwila Parkway Site	6
Tukwila Pond Park	7
Tukwila Pool MPD	3
West Valley Riverbank	7

map created by **FORTERRA** in partnership with the City of Tukwila.


Map I
Cecil Moses Memorial Park
North Wind's Weir
Chinook Wind
Duwamish Gardens
S. 115th Street Riverbank
Shown in full on Map 2
Duwamish River
Tukwila International Blvd
East Marginal Way S
E Marginal Way S
27th Ave S
S 112th St
S 116th St
S 116th Way
Tukwila Intl Blvd
City of Burien
99
599
Tree-iage Categories
VALUE
Modified Tree Composition
HIGH
MEDIUM
LOW
1 2 3
4 5 6
7 8 9
LOW MEDIUM HIGH
Invasive Species Cover
THREAT
Non-forested Area
Open Water
Landscaped or Hardscaped
Habitat Management Unit (HMU) boundaries are delineated by a thin white outline. Each HMU on this map is portrayed with a fill color corresponding to the Tree-iage Category that best characterizes it, and is labeled with an identification letter unique to that park or site.
Feet
0
500
1,000
map created by FORTERRA in partnership with the City of Tukwila.
Tree-iage field assessment conducted by American Forest Management, Inc., October 2015

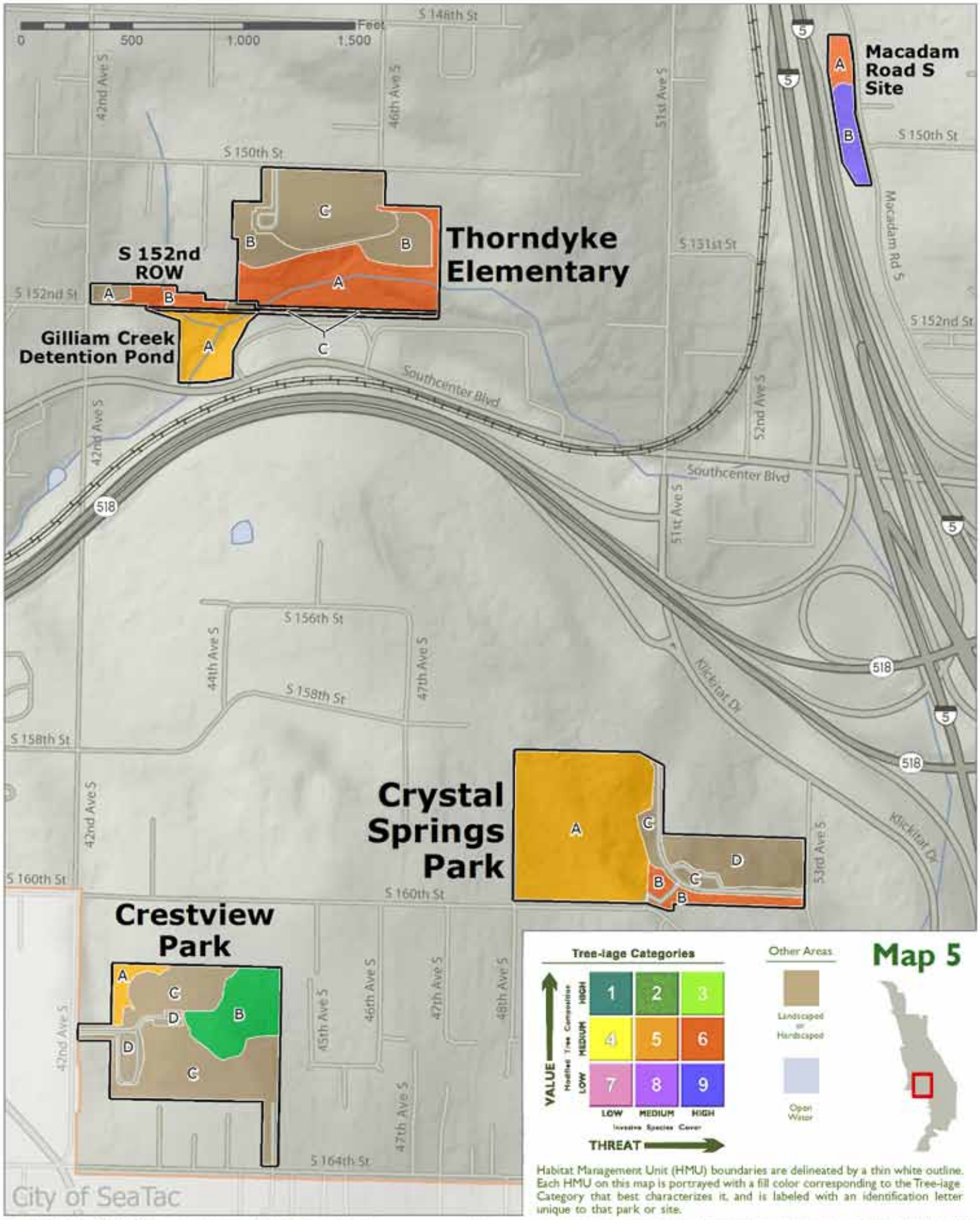

Map 2
Tree-iage Categories
VALUE
Modified Tree Composition
HIGH
MEDIUM
LOW
1 2 3
4 5 6
7 8 9
LOW MEDIUM HIGH
Invasive Species Cover
THREAT
Habitat Management Unit (HMU) boundaries are delineated by a thin white outline. Each HMU on this map is portrayed with a fill color corresponding to the Tree-iage Category that best characterizes it, and is labeled with an identification letter unique to that park or site.
Non-forested Area
Open Water
Landscaped or Hardscaped
Ryan Hill
Ryan Creek
City of Seattle
Duwamish Hill
Duwamish Hill Preserve
See inset map at right for more detail.
Allentown Fire Station
S. 115th Street Riverbank
42nd Ave S/ S 115th St Riverbank
Siccardi Site
Duwamish Park
Duwamish Hill Preserve
Tukwila Community Center
S. 125th Street Site
Codiga Park
Duwamish Restoration Challenge
Riverton Creek
S 115th St
42nd Ave S
44th Ave S
46th Ave S
44th Pl S
S 122nd St
East Marginal Way S
Interurban Ave S
S 124th St
S 126th St
S 128th St
47th Ave S
51st Pl S
50th Pl S
49th Ave S
S Ryan Way
Duwamish River
Feet
0 500 1,000 1,500
map created by FORTERRA in partnership with the City of Tukwila
Tree-iage field assessment conducted by American Forest Management, Inc., October 2015

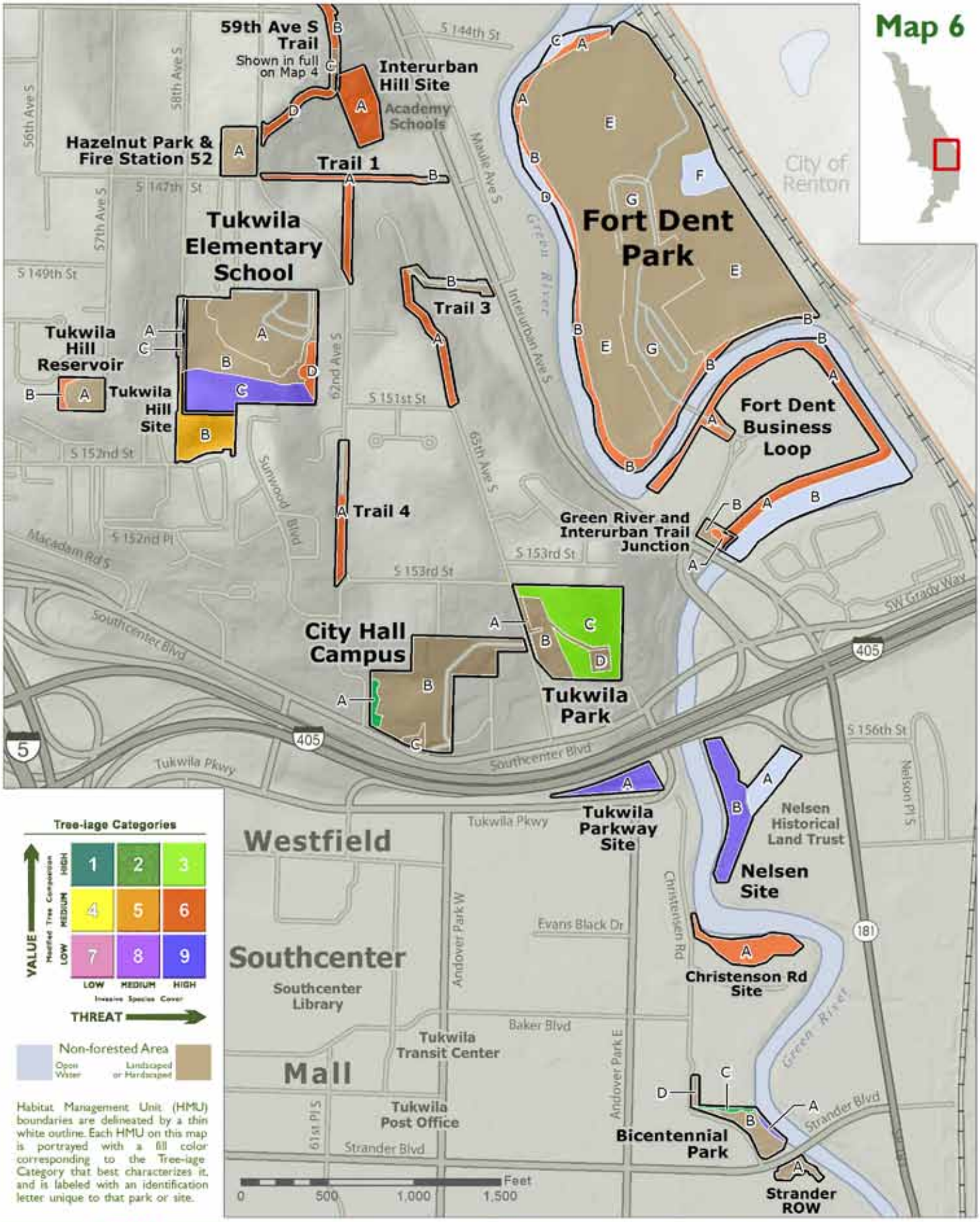

Map 3
TIB &
S.130th St
Riverton
Park
Riverton
Mini Park
Cascade
View
Elementary
Southgate
Park
Foster High School
and
Showalter Middle School
Foster
Library
Tukwila
Pool
MPD
Foster
Fire Station
#54
Cascade View
Community Park
City of
SeaTac
S 130th St
S 132nd St
S 133rd St
S 135th St
S 136th St
S 137th St
S 139th St
S 140th St
S 141st St
S 142nd St
S 144th St
S 146th St
S 148th St
Interurban Ave S
Macadam Rd S
Military Rd S
E Marginal Way S
Tree-iage Categories
VALUE
Modified Tree Composition
HIGH
MEDIUM
LOW
1
2
3
4
5
6
7
8
9
LOW
MEDIUM
HIGH
Invasive Species Cover
THREAT
Habitat Management Unit (HMU) boundaries are delineated by a thin white outline. Each HMU on this map is portrayed with a fill color corresponding to the Tree-iage Category that best characterizes it, and is labeled with an identification letter unique to that park or site.
Non-forested Area
Open Water
Landscaped or Hardscaped
Feet
0
500
1,000
1,500
map created by FORTERRA in partnership with the City of Tukwila.
Tree-iage field assessment conducted by American Forest Management, Inc., October 2015



map created by **FORTERRA** in partnership with the City of Tukwila.

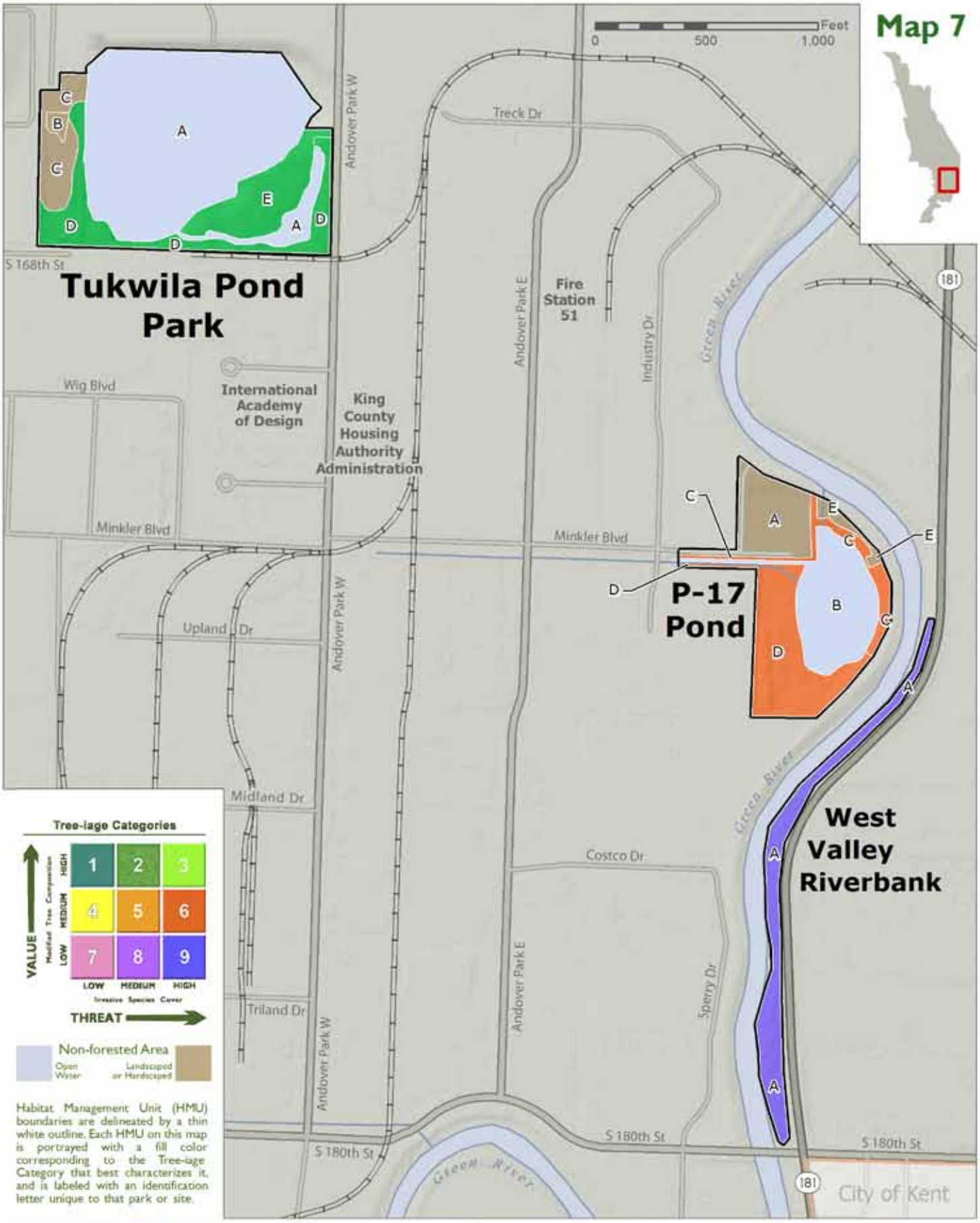
Tree-iage field assessment conducted by American Forest Management, Inc., October 2015


Feet
0
500
1,000
1,500
S 148th St
42nd Ave S
46th Ave S
51st Ave S
Macadam Road S Site
S 150th St
Thorndyke Elementary
S 151st St
Macadam Rd S
S 152nd ROW
S 152nd St
Gilliam Creek Detention Pond
Southcenter Blvd
52nd Ave S
518
5
S 156th St
44th Ave S
47th Ave S
S 158th St
Klickitat Dr
Crystal Springs Park
53rd Ave S
S 160th St
Crestview Park
45th Ave S
48th Ave S
S 164th St
City of SeaTac
Tree-iage Categories
Modified Tree Composition
HIGH
MEDIUM
LOW
VALUE
Invasive Species Cover
THREAT
Other Areas
Landscaped or Hardscaped
Open Water
Map 5
Habitat Management Unit (HMU) boundaries are delineated by a thin white outline. Each HMU on this map is portrayed with a fill color corresponding to the Tree-iage Category that best characterizes it, and is labeled with an identification letter unique to that park or site.
map created by FORTERRA in partnership with the City of Tukwila.
Tree-iage field assessment conducted by American Forest Management, Inc., October 2015

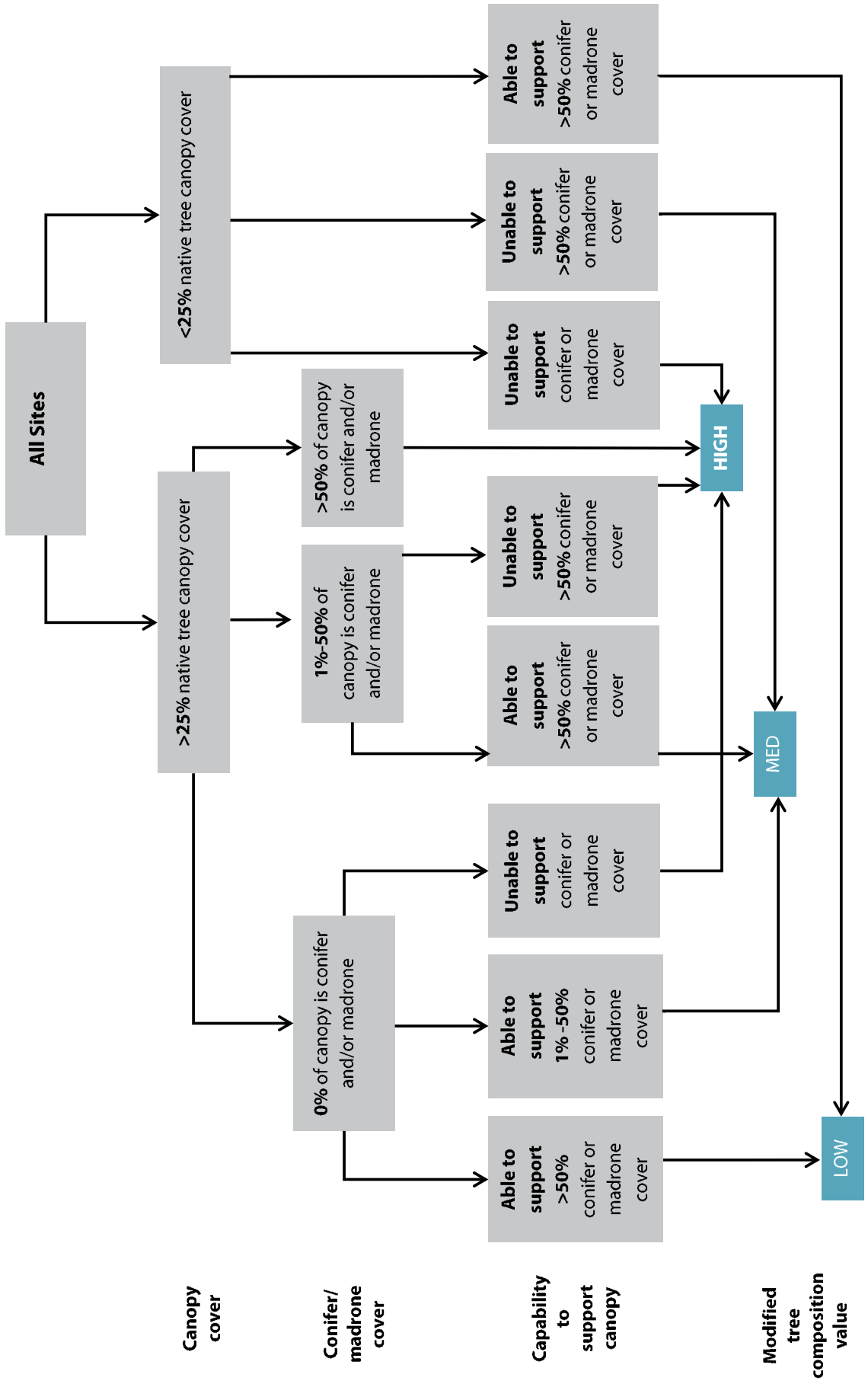


map created by **FORTERRA** in partnership with the City of Tukwila.

Tree-iage field assessment conducted by American Forest Management, Inc., October 2015


Map 7
Feet
0
500
1,000
Tukwila Pond Park
S 168th St
Andover Park W
Treck Dr
Andover Park E
Fire Station 51
Industry Dr
Green River
181
Wig Blvd
International Academy of Design
King County Housing Authority Administration
Minkler Blvd
Upland Dr
P-17 Pond
Midland Dr
West Valley Riverbank
Costco Dr
Sperry Dr
Triland Dr
S 180th St
City of Kent
Tree-iage Categories
VALUE
Modified Tree Composition
HIGH
MEDIUM
LOW
THREAT
Invasive Species Cover
Non-forested Area
Open Water
Landscaped or Hardscaped
Habitat Management Unit (HMU) boundaries are delineated by a thin white outline. Each HMU on this map is portrayed with a fill color corresponding to the Tree-iage Category that best characterizes it, and is labeled with an identification letter unique to that park or site.
map created by FORTERRA in partnership with the City of Tukwila.
Tree-iage field assessment conducted by American Forest Management, Inc., October 2015

APPENDIX B. FOREST LANDSCAPE ASSESSMENT TOOL (FLAT) FLOWCHART FOR HABITAT COMPOSITION VALUE



APPENDIX C. MANAGEMENT-UNIT ACRES PER TREE-IAGE CATEGORY

Site Name	Tree-iage Category									Acres per site
	1	2	3	4	5	6	7	8	9	
42nd Ave S/S 115th St Riverbank						4.3				4.3
57th Ave South Mini Park									0.1	0.1
59th Ave S Trail						1.1				1.1
Allentown Fire Station #53						1.5			0.6	2.1
Bicentennial Park		0.1							0.1	0.3
Cecil Moses Memorial Park	0.6									0.6
Chinook Wind									1.7	1.7
Christenson Rd Site						1.4				1.4
City Hall Campus		0.3								0.3
Codiga Park				1.6				2.0		3.6
Crestview Park		2.6			0.6					3.1
Crystal Springs Park					9.1	1.0				10.2
Duwamish Gardens							1.8			1.8
Duwamish Hill Preserve	0.1	0.1		1.4	2.7	0.3	3.9	0.7		9.3
Duwamish Restoration Challenge				1.2					2.0	3.2
Fort Dent Business Loop						4.0				4.0
Fort Dent Park						3.1				3.1
Foster Golf Links					3.3	2.9				6.2
Foster High School and Showalter Middle School						3.6				3.6
Foster Point Lookout Park						0.2				0.2
Gilliam Creek Detention Pond					1.9					1.9
Interurban Hill Site						1.7				1.7
Macadam Rd S Site						0.5			0.9	1.4
Macadam Wetlands & Winter Garden					2.0	6.4				8.4
Nelsen Site									2.0	2.0
North Wind's Weir	0.6									0.6
P-17 Pond						5.4				5.4
Pamela Drive Site									0.7	0.7
Riverton Creek									0.4	0.4
Riverton Park					0.6					0.6
S 115th Street Riverbank									0.3	0.3
S 152nd ROW						0.8				0.8
S. 125th St Site									0.2	0.2
S. 140th St. ROW & Riverbank Parcels						0.8				0.8
SCL - Duwamish Hill							2.2		0.4	2.5
SCL - Ryan Creek					1.6		1.7		3.2	6.5
SCL - Ryan Hill									1.8	1.8
Siccardi Site									0.9	0.9
Southgate Park						11.6				11.6

APPENDIX C. CONT.

Site Name	Tree-iage Category									Acres per site
	1	2	3	4	5	6	7	8	9	
Thorndyke Elementary						5.0				5.0
TIB & S 130th St									0.2	0.2
Trail 1						0.9				0.9
Trail 3						0.8				0.8
Trail 4						0.8				0.8
Trail Junction: Green River and Interurban						0.2				0.2
Tukwila Community Center						0.8				0.8
Tukwila Elementary School						0.4			2.8	3.3
Tukwila Hill Reservoir						0.2				0.2
Tukwila Hill Site					1.9				0.1	2.1
Tukwila Park			4.3							4.3
Tukwila Parkway Site									0.9	0.9
Tukwila Pond Park		6.3								6.3
West Valley Riverbank									3.3	3.3
Acres per tree-iage category	1.3	9.4	4.3	4.2	23.7	59.5	9.6	2.7	22.8	137.5

APPENDIX D OVERSTORY SPECIES DOMINANCE BY MU ACRES

Scientific name	Common name	Primary species by MU acres	Secondary species by MU acres	Tertiary species by MU acres
Acer macrophyllum	Bigleaf maple	43.2	26.6	8.8
Alnus rubra	Red alder	2.0	54.5	21.2
Sequoia sempervirens	Coast redwood	0.5	5.4	0.4
Betula papyifera	Paper birch			0.9
Betula pendula	Silver birch			0.2
Fraxinus latifolia	Oregon ash	0.5		
Pinus contorta	Shore pine	0.1	0.2	0.6
Picea sitchensis	Sitka spruce			0.9
Populus balsamifera	Black cottonwood	57.9	8.6	17.1
Prunus emarginata	Bitter cherry	0.8	1.8	4.4
Pseudotsuga menziesii	Douglas-fir	7.6	10.8	20.7
Rhamnus purshiana	Cascara			3.3
Salix lucida	Pacific willow	1.7	0.9	9.0
Salix sitchensis	Sitka willow	3.0	5.1	0.8
Arbutus menziesii	Pacific madrone	0.3		
Thuja plicata	Western redcedar	0.2	0.9	18.3

APPENDIX E. UNDERSTORY SPECIES DOMINANCE BY MU ACRES

Scientific name	Common name	Primary	Secondary
Rubus spectabilis	Salmonberry	29.3	8.1
Corylus cornuta	Beaked hazelnut	19.0	8.4
Grass species	Grass	17.3	2.2
Salix lutea	Yellow willow	14.2	8.1
Symphoricarpos albus	Snowberry	12.3	18.1
Cornus sericea	Red osier dogwood	11.3	22.6
Spiraea douglasii	Hardhack; spiraea	7.2	
Gaultheria shallon	Salal	3.1	
Pteridium aquilinum	Bracken fern	2.8	
Juncus effusus	Soft rush	1.7	
Polystichum munitum	Sword fern	1.3	15.3
Salix scouleriana	Scouler's willow	0.8	3.1
Holodiscus discolor	Oceanspray	0.6	0.2
Malus fusca	Pacific crabapple	0.6	
Oemleria cerasiformis	Indian plum	0.4	20.2
Equisetum fluviatile	Swamp horsetail	0.3	
Physocarpus capitatus	Pacific ninebark	0.2	3.1
Mahonia nervosa	Dull Oregon grape	0.1	6.2
Rubus ursinus	Trailing blackberry		2.0
Willow species	Willow (unknown sp.)		1.7
Mahonia aquifolium	Tall Oregon grape		0.6

APPENDIX F. INVASIVE SPECIES OCCURRENCES BY MU ACRES

Scientific name	Common name	MU acres	% of project area
Rubus armeniacus	Himalayan blackberry	121.8	88%
Hedera helix	English ivy	70.0	51%
Phalaris arundinacea	Reed canary grass	57.1	41%
Prunus laurocerasus	Cherry laurel	38.5	28%
Calystegia sepium	Hedge bindweed	28.4	21%
Polygonum x sp	Knotweed	14.4	10%
Cytisus scoparius	Scotch broom	12.9	9%
Ilex aquifolium	English holly	11.9	9%
Crataegus monogyna	English hawthorn	11.0	8%
Tanecetum vulgare	Common tansy	8.6	6%
Geranium robertianum	Herb Robert	1.9	1%
Grass species	Grass	1.8	1%
Phragmites australis	Common reed	1.7	1%
Robinia pseudoacacia L.	Black locust	1.0	1%
Cirsium arvense	Canada thistle	0.1	<1%
Solanum dulcamara	Bittersweet nightshade	0.1	<1%

APPENDIX G. PUBLIC INPUT

The following answers provide a summary of the public input recieved from members of the community. Information was solicited in person at various public venues as well as online.

When you spend time outside, what do you like to do?

Activity	Percent of Responses
Relax	67%
Enjoy nature	66%
Spend time with friends and family	65%
Exercise	60%
Play sports and games	35%
Picnic and BBQ	34%
Spend time alone	27%
Fish	12%
Walk dogs	3%
Garden	2%
Identify wildlife and native flora	2%
Bike	1%

What is your favorite Tukwila Park or place to go outside?

Park or Natural Area	Number of Responses
Green River Trail	12
Duwamish Hill Preserve	12
Duwamish Park	6
Tukwila Community Center	6
Riverton Park	6
Fort Dent	5
Crestview Community Park	5
Macadam Winter Garden	4
Foster	4
Cascade View Community Park	4
Tukwila Park	3
Crystal Springs	3
Bicentennial Park	2
North SeaTac Park	1
Codiga Park	1
Namaste Garden	1
Christensen Trail	1

APPENDIX G. CONT.

Where do you typically learn about community news and events?

Response	Number of Responses
Tukwila Reporter	16
Word of mouth/neighbors/coworkers/landlord	16
Online	13
Email	13
Social media (Facebook and Twitter)	12
Hazelnut	12
Fliers around town (library, coffee shops, community center, in parks)	12
Neighborhood listserv	10
Through the School District	5
City website	4
Mail	3
Parks and Rec Guide	2
Next Door	2
Forterra	2
Tukwila Talk	1
Text message	1

73% of the survey takers live in Tukwila. The following Tukwila neighborhoods were represented:

Tukwila Neighborhood	Number of Responses
Allentown	13
Riverton	11
Tukwila Hill	8
McMicken	8
Foster	6
Cascade View	4
Thorndyke	1
Poverty Hill	1
Tukwila South	1

APPENDIX G. CONT

What would make volunteering easier or more appealing to you?

Response	Number of Responses
Easy parking options	19
Clear communication about events	10
Easy access from public transportation	8
Transportation from a central location	7
Feel like you are making a difference	6
Childcare provided	6
A social atmosphere at volunteer events	4
Volunteer opportunities on the weekend	3
Volunteer opportunities on weekdays	3
Knowing that volunteer work will be maintained	3
Consistent scheduling for volunteer opportunities	2
Different types of volunteer opportunities	2
Volunteer opportunities after work hours	2
Informing the school district about opportunities	2
Not enough time to volunteer	2
Food and coffee at volunteer events	1
Volunteer opportunities held in my neighborhood	1
Kid-friendly activities	1
Volunteer opportunities during lunch hours	1
Volunteer event reminders	1
Interpreters available at volunteer events	1
Volunteering with coworkers at a work-sponsored event	1
Ongoing volunteer opportunities with no set schedule	1

APPENDIX G. CONT.

Of the 83 individuals surveyed, the following percent identified as:

Race	Percent of Responses
White or Caucasian	67%
Asian/ Pacific Islander	14%
African-American or Black	11%
Latino	4%
Native American	2%
Other	1%
Chose not to say	6%

Age range of the 83 individuals who responded to the survey:

Age Range	Number of Responses
Under 18	2
18 – 24	4
25 - 34	11
35 - 44	20
45 - 54	20
55 - 64	14
65 and older	7
Chose not to say	5

Survey answers were collected online and in-person. Of the 83 surveys filled out, the responses were collected from the following sources:

Survey Source	Number of Responses
Online Survey	43
Outreach Tabling at Public Events	37

APPENDIX H. SHORT - AND LONG-TERM STRATEGIC PLAN AND BENCHMARKS

Short-Term Strategic Plan Benchmarks 2013–2017

	2017	2018	2019	2020	2021
FIELD	Develop stewardship plans for two priority sites	Continue work on 1.5 previously enrolled acres	Continue work of 3.5 previously enrolled acres	Continue work on 6.5 previously enrolled acres	Continue work on 9.5 previously enrolled acres
	Enroll 1.5 acres in initial restoration	Enroll 2 new aces into restoration	Enroll 3 new aces into restoration	Enroll 3 new acres into restoration	Enroll 4 new acres into restoration
	Develop tracking plan	Develop stewardship plans for any new sites	Develop stewardship plans for any new sites	Develop stewardship plans for any new sites	Develop stewardship plans for any new sites

COMMUNITY	Recruit and manage 3,000 volunteer hours	Recruit and manage 3,000 volunteer hours	Recruit and mange 3,200 volunteer hours	Recruit and manage 3,500 volunteer hours	Recruit and manage 3,800 volunteer hours
	Establish a stewardship program	Recruit 5 new stewards; support all active stewards	Recruit 2 new stewards; support all active stewards	Recruit 2 new stewards; support all active stewards	Recruit 2 new stewards; support all active stewards
	Publicize in local media	Plan and host signature community planting event Host volunteer appreciation event Host 1 community appreciation event	Host signature community planting event Host volunteer appreciation event Host 2 community appreciation event	Host signature community planting event Host volunteer appreciation event Host 3 community appreciation event	Host signature community planting event Host volunteer appreciation event Host 5 community appreciation event
	Develop basic branded outreach and promotional items	Work with schools on youth stewardship program	Create updated branded outreach and promotional materials		Publicize first 5 years of work Update community engagement plan

	2017	2018	2019	2020	2021
RESOURCES	Convene agency partners for preliminary coordination	Establish management team and working partners	Seek additional partners	Identify and pursue funding to support field, community and administrative work as needed	Identify and pursue funding to support field, community and administrative work as needed
	Develop business engagement plan	Seek additional partners	Identify and pursue funding to support field, community and administrative work as needed	Expand capacity for volunteer and community events	Explore options for more formalized management structure if needed
		Identify and pursue funding to support field, community and administrative work as needed	Expand business engagement		

ADMINISTRATION	Begin planning for long-range management structure		Finalize plans for management structure	Establish working Community Advisory Committee and Management Team	
	Publish and distribute 20-year management plan	Write 2017 annual report	Write 2018 annual report	Write 2019 annual report	Write 2020 annual report
	Develop 2018 work plan	Develop 2019 work plan	Develop 2020 work plan	Develop 2021 work plan	Develop 2022 work plan

	2022-2026	2027-2031	2032-2036
FIELD	Continue work on previously enrolled acres: 13.5 in 2022; 18.5 in 2023; 24.5 in 2024; 31.5 in 2025; 39.5 in 2026	Continue work on previously enrolled acres: 47.5 in 2027; 55.5 in 2028; 63.5 in 2029; 71.5 in 2030; 79.5 in 2031	Continue work on previously enrolled acres: 85.5 in 2032; 87.5 in 2033-2036
	Enroll 5 acres in 2022; 6 acres in 2023; 7 acres in 2024 ; 8 acres in 2025 & 2026	Enroll 8 acres in 2027; 8 acres in 2028; 8 acres in 2029; 8 acres each year in 2030; and 6 acres in 2031	Enroll any remaining 2 acres, additional sites and acquisitions if needed
	Conduct 5-year monitoring and BMP review	Conduct 10-year monitoring and BMP review	Conduct 15-year monitoring and BMP review
COMMUNITY	Recruit and manage 4,000 volunteer hours annually Support 20 active stewards	Recruit and manage 4,000 volunteer hours annually Support 25 active stewards	Recruit and manage 3,000 volunteer hours annually Support 25 active stewards
	Host annual signature planting event Host annual volunteer appreciation event	Host annual signature planting event Host annual signature planting event	Host annual signature planting event Host annual signature planting event
	Host bimonthly community appreciation events	Host bimonthly community appreciation events	Host bimonthly community appreciation events
RESOURCES	Evaluate needs, costs and resources based on first 5 years of work	Evaluate and update methods	Evaluate and update methods
	Identify and pursue funding to support field, community and administrative work needed	Identify and pursue funding to support field, community and administrative work needed	Identify and pursue funding to support field, community and administrative work needed Ensure proper funding base is in place for long-term maintenance, monitoring and community engagement
	Develop annual work plan and write annual report of accomplishments	Develop annual work plan and write annual report of accomplishments	Develop annual work plan and write annual report of accomplishments

APPENDIX I. GLOSSARY OF TERMS

Adaptive Management
A structured, repeating process of decision making aimed at better understanding a management system through monitoring, evaluation, and development of new management strategies. The Green Tukwila Partnership will utilize an adaptive management strategy to inform its administrative and restoration practices over time.

Balanced Scorecard
A strategic planning and management tool developed to measure both financial and nonfinancial performances against strategic goals. Tukwila's balanced scorecard measures the performance across three key elements: fieldwork, community, and resources.

Canopy Cover
The percent of a forest floor or specific geographic area covered by tree crowns. Assessed using aerial orthophotographs as well as ground-based techniques, it can be used for all trees in a given geographic area or specific tree species. Canopy cover has been shown to be an important ecological indicator used for distinguishing plant and animal habitats as well as assessing on-the-ground conditions in urban areas. The canopy cover of Tukwila's forested parkland was assessed using aerial orthophotographs followed by on-the-ground field verification.

Conifers
Cone-bearing trees, most of which are evergreen, with needle or scalelike leaves. Examples include pine, fir, hemlock, and spruce. The dominant conifers found in Tukwila's urban forest include Douglas-fir, western redcedar, and western hemlock.

Crown Closure
Canopy closure is the proportion of the sky that is obscured by leafy vegetation when viewed from a single point on the ground, looking up. Closure is affected by tree heights and tree canopy widths and takes into account light infiltration into the understory. Canopy closure is a data measurement in the Forest Landscape Assessment Tool (FLAT) used to categorize Tukwila's forested parkland for the 20-Year Plan.

Deciduous
A tree or shrub that loses its leaves or needles during the fall and winter months (in contrast to an evergreen plant). Examples found in Puget Sound forests include bigleaf maple, red alder, and snowberry.

Ecosystem
The interactive community or relationships of living (biotic) organisms such as plants, animals, and microbes with nonliving (abiotic) components such as air, water, soils, and weather.

Forest Restoration
Actions and management to reestablish or enhance processes that support a healthy forest's structure, ecological functions, and biodiversity levels. Restoration actions may include removal of nonnative invasive plants, applying mulch, and planting native trees, shrubs, and ground cover. In an urban environment, the natural ecological processes may never be fully restored. Therefore, forests will need ongoing management with long-term maintenance and monitoring.

Green Cities Network
The combined regional group of Green City Partnerships, which currently includes Seattle, Kirkland, Tacoma, Redmond, Kent, Puyallup, Tukwila, Snoqualmie and Everett. The Network is not a formally defined entity; rather, it is made up of the city partners, Forterra staff, other nonprofits, and participating volunteers who contribute to achieving the goals of each Green City. Network participants are invited to share best management practices, current relevant research, and funding opportunities.

Green City Partnership
A public-private venture between a local municipality (e.g., parks departments, public works, utilities, and other government agencies), community groups, and Forterra. The vision of each Green City Partnership is to create a healthy, livable city with sustainable urban forests and natural areas that connect people to nature through community-based stewardship.

Greenspace
A protected area of undeveloped landscape such as grass, trees, or other vegetation set apart for recreational, aesthetic, or ecological purposes. In the context of the 20-year plan, greenspace refers specifically to lawns, greenbelts, meadows, wetlands, and forests within the city of Tukwila.

Invasive plants
Introduced nonnative plant species with traits that allow

them to thrive outside their natural range and outcompete native plants. Invasive plants are typically adaptable and aggressive, with high reproductive capacity, and likely to cause economic and/or environmental harm.

Madrone
Arbutus menziesii (aka Pacific madrone, madrona) is a broadleaf evergreen tree native to western North America, particularly to Puget Sound lowland forests. The bark is a rich orange-red color that when mature naturally peels away in thin sheets, leaving a smooth greenish appearance. The Pacific madrone is in decline, especially in urban areas, and is a difficult species to reestablish. The species offers important habitat and supports a unique plant community often found on drier slopes along shorelines, or in areas with sandy or rocky, well-drained soils.

MU (Management Unit)
A defined geographic area or forest stand within a park characterized by the vegetation type or conditions present. Forest stands within Tukwila parks were delineated into MUs based on one of five categories: forested, natural (nonforested), open water, hardscaped, or landscaped. MUs were then further designated based on tree-iage category as described in the 20-year plan.

Mulch
A protective covering, usually of organic matter such as leaves, straw, bark, or wood chips, placed around plants to prevent weed growth, moisture evaporation, and the freezing of roots. Covering the ground with mulch is a maintenance practice used in urban forest restoration following invasive plant removal and native plant installation.

Natural Area
Undeveloped land, consisting of native and nonnative vegetation, that is not maintained as an ornamental landscape, and where normal ecological cycles proceed. Natural areas can be public or private land. The forest assessment conducted for the 20-year plan defines natural areas as those HMUs with less than 25% tree cover, in contrast to "Forested Areas," which have more than 25% tree cover.

Orthophotograph
An aerial photograph that has been adjusted for topographic relief, lens distortion, and camera tilt. It can be used to measure true distances, because it is an accurate representation of the Earth's surface, and is often used with geographic information systems (GIS).

Overstory
The uppermost layer of branches and foliage that forms the forest canopy. Common overstory trees found in Puget Sound forests include Douglas-fir, western redcedar, western hemlock, and bigleaf maple.

Photosynthesis
A process used by plants and some algae to convert light energy from the sun, carbon dioxide, and water into carbohydrates that provide sustenance for those organisms. Photosynthesis takes place in the chloroplast cells of leaves. The primary by-product of photosynthesis is oxygen.

Riparian
Pertains to the area along the banks of a river, stream, or lake.

Runoff
Runoff refers to unfiltered rainwater that reaches nearby water bodies by flowing across impervious surfaces such as roads, parking lots, driveways, roofs, and even compacted soils in landscapes. When the landscape is undeveloped or soils are not compacted, rainwater soaks into forest and meadow soils, where it is filtered by natural processes, slowly feeding into underground aquifers, streams, and lakes. The filtration process removes pollutants such as motor oils, gasoline, fertilizers, and pesticides. Forested parklands in Tukwila assist in reducing stormwater runoff entering Possession Sound, the Snohomish River, and Everett's other streams and wetlands.

Tree Canopy
The uppermost layer of the forest, formed by leaves and branches of dominant tree crowns. The tree canopy forms the forest overstory.

Tree Canopy Vigor
Vigor refers to a tree's active, healthy growth. Plants with "low tree canopy vigor" have stunted growth, premature leaf drop, late spring-leaf development, sparse foliage, light green or yellow foliage, twig and branch dieback, or other abnormal symptoms. A combination of factors (e.g., flooding, shifts in environmental conditions, or physical damage) reduces a tree's vigor. Stress on a tree can make it vulnerable to diseases and insects that accelerate its decline.

Understory
The vegetation that grows below the forest canopy. Understory plants consist of saplings of canopy trees, together with smaller understory trees, shrubs, and herbs. Examples of understory plants found in Puget Sound forests

include vine maple, beaked hazelnut, tall Oregon grape, salal, and sword fern.

Woody Shrub

A woody, multistemmed plant that grows to less than 26 feet tall and is found in the forest understory. Examples found in Puget Sound forests include red flowering currant and tall Oregon grape.

GREEN
TUKWILA
PARTNERSHIP