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Street Tree Inventory Report
Irvington Neighborhood

November 2015

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Cover Photos (from top left to bottom right):
1) The fruit and foliage of a rare Japanese chinquapin (*Castanopsis cuspidata*).
2) Latex filaments are visible when a hardy rubber tree (*Eucommia ulmoides*) leaf is split.
3) A large pecan (*Carya illinoinensis*), which is a rare sight in Portland.
4) Two Northern catalpas (*Catalpa speciosa*), Portland Heritage Trees #24 and 25.
5) Close-up view of acorns growing on a bambooleaf oak (*Quercus myrsinifolia*).
6) A row of red maples (*Acer rubrum*) display their vivid fall foliage.
7) The lacy bark of a Chinese elm (*Ulmus parvifolia*).
8) Feathery foliage and developing cones on a dawn redwood (*Metasequoia glyptostroboides)*.

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Volunteers, guided by Portland Parks & Recreation Urban Forestry staff, collected data on all 5,601 street trees within Irvington neighborhood to compile the neighborhood's first complete street tree inventory. The data are being used to inform the creation of a Neighborhood Tree Plan to guide volunteers in caring for their community's trees.

Key Findings

This report provides the results of a street tree inventory conducted in the Irvington neighborhood in 2015, along with Portland Parks & Recreation (PP&R) Urban Forestry staff recommendations for the Irvington tree team. Over the course of four work days, 72 volunteers contributed more than 380 hours collecting data on each of the neighborhood's 5,601 street trees.

URBAN FOREST STRUCTURE

- **Irvington's street tree population is dominated by maples, cherry, and dogwood and does not meet recommended species diversity guidelines.** While 106 tree types were found in this inventory, only two families, Rosaceae and Sapindaceae, account for more than 54% of the street tree resource. Furthermore, both the *Acer* (maple) and *Prunus* (plum, cherry) genera are over represented leaving Irvington's street tree population vulnerable to pests, pathogens, and effects of a changing climate.

- **The dominance of broadleaf deciduous trees (95%) points to a need to plant more evergreen trees for year-round benefits and to help create a more resilient, sustainable urban forest.**

- **Only 15% of trees in Irvington are young (<3" DBH), leaving few trees to offset mortality as the population ages.** Frequent planting of young trees helps to ensure a stable street tree population with a healthier age distribution in the future.

- **Only 21% of Irvington's street trees are large form varieties.** Large form trees are necessary to maintain canopy cover and the benefits they provide for Irvington's residents. Planting the estimated 470 large available spaces identified in this inventory and replacing poor and undersized trees in large planting sites will maximize tree canopy in Irvington's rights-of-way.

TREE CONDITION

- **The majority (94%) of trees inventoried in Irvington are in fair or good condition.** However, 42% and 35% of the trees that are rated poor are in the Rosaceae and Sapindaceae families, respectively.

PLANTING SITES AND STOCKING LEVEL

- **Although 79% of street tree planting sites have trees in Irvington, there are 1,401 sites that are empty and ready for planting.**

- **Only one-quarter of large planting sites contain trees large enough for the site.** Small form trees planted in large planting sites are a missed opportunity because larger trees contribute many times more benefits than do smaller ones.

URBAN FOREST VALUE AND BENEFITS

- **Irvington's street trees produce an estimated $1,342,975 annually in environmental and aesthetic benefits.** The replacement value of this resource is nearly $36 million. Planting efforts focused on appropriately sized trees distributed across the neighborhood will ensure that future benefits are equitably distributed among all residents.

*Clockwise from top left: 1) The fragrant evergreen foliage of a camphor tree (*Cinnamomum japonicum*), a member of the laurel family that is unusual in Portland. 2) Twenty-one Portland Heritage Trees are located in Irvington, including this sycamore maple (*Acer pseudoplatanus*), which is Heritage Tree #305. 3) At 63.3" DBH, this elm (*Ulmus *sp.*) is the largest diameter street tree in Irvington. 4) These silverleaf oaks (*Quercus hypoleucoides*), an evergreen oak species, were the first of their kind to be planted as street trees in Portland.*

About Portland's Street Tree Inventory

THE IMPORTANCE OF STREET TREES

Street trees are an important public asset in urban environments, serving as a buffer between our transportation corridors and our homes while enhancing the livability of our city. As integral components of a community's green infrastructure, street trees provide multiple economic, environmental, and social benefits such as cleaner air and water, cooler summer temperatures, safer streets, and increased property values. Unlike traditional, "grey" infrastructure, which begins to deteriorate the moment it is installed, the benefits that street trees provide increase over the lifetime of the tree, making their planting and maintenance one of the best investments a city and its residents can make.

While street trees are only one component of Portland's urban forest, they are particularly important because they are the trees that residents interact with most. Having adequate information about the street tree population allows a community to make informed decisions about species selection, planting, and maintenance priorities. Information on the location, condition, and diversity of the street tree population enables our communities to steward this resource and ensure its continued benefits into the future. Undertaking a street tree inventory is not only an investment in the current and future well-being of the trees, but in the community itself.

Urban forests are complex, living resources that interact both positively and negatively with the surrounding environment. They produce multiple benefits and have associated management costs. In order to fully realize the benefits, a sound understanding of the urban forest resource is needed. This understanding starts at the most basic level with a forest inventory to provide baseline data for management decisions.

THE INVENTORY PROCESS

Portland's Tree Inventory Project began with a pilot street tree inventory in 2010, and since then 46 neighborhoods have partnered with Urban Forestry to inventory street trees and create action-oriented Neighborhood Tree Plans. To date, volunteers have identified, measured, and mapped more than 150,000 street trees! Neighborhood groups interested in trees begin by gathering volunteers to help conduct an inventory. Urban Forestry staff provides training, tools, and event organization. Together information is collected on tree species, size, health, site conditions, and available planting spaces.

Urban Forestry staff analyze data for each neighborhood and present findings to stakeholders at an annual Tree Summit in November. At the summit, neighborhood groups begin developing tree plans that set achievable strategies to improve existing trees, expand tree canopy, and connect the neighborhood with City and nonprofit resources. The resulting Neighborhood Tree Plan is based on the status and health of street trees and recommends specific actions to improve and expand this resource. Urban Forestry then partners with groups to organize stewardship events, including pruning, planting, and educational workshops.

The Tree Inventory Project supports Portland's Urban Forest Management Plan goals: to manage the urban forest in order to maximize community benefits for all residents; to develop and maintain support for the urban forest; and to protect, preserve, restore, and expand Portland's urban forest.

Neighborhood tree teams and volunteers are the backbone of this inventory. This partnership between residents and government is key to successful management of street trees in Portland, where Urban Forestry regulates street tree removal, planting, and maintenance through a permitting process, and property owners are responsible for the care and maintenance of trees. Creating a healthy urban forest depends on the active engagement of residents to care for their street trees.

If you would like to get involved with Irvington's urban forest, contact the Irvington Community Association by visiting http://www.irvingtonpdx.com or contact Urban Forestry.

Data from the inventory are available to the public in spreadsheet or ArcGIS format. Visit the Tree Inventory Project website at http://portlandoregon.gov/parks/treeinventory to learn more about the project and download reports, data, and maps.

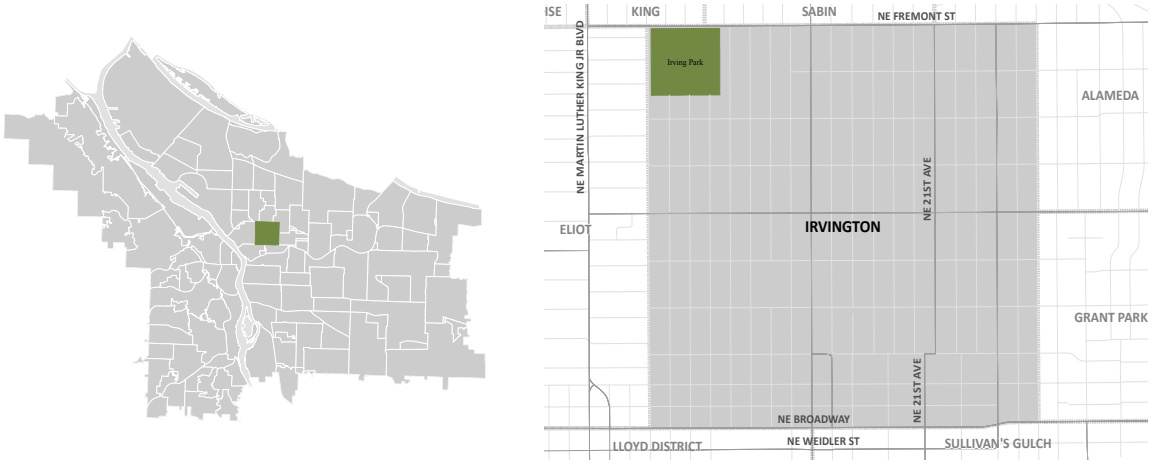
*Clockwise from top left: 1) Large, empty strips provide opportunities for planting the next generation of Irvington's tree canopy. 2) Katsura trees (*Cercidiphyllum japonicum*) located in a wide strip without overhead wires. This planting site could accommodate a larger form tree that would provide more benefits over its lifetime. 3) Planting large form trees such as these young ginkgos (*Ginkgo biloba*) will ensure that Irvington maintains its canopy decades into the future as currently mature trees decline and require replacing.*

Neighborhood Characteristics

A neighborhood's history and land use have an important effect on the presence and condition of street trees and the urban forest. Over time, different development patterns have been more or less favorable to street trees. Areas of Portland's neighborhoods that were designed without the inclusion of street trees or with small planting spaces limit the potential for street trees. With redevelopment of areas and new designs that include adequate space for trees, there is opportunity for increased use of street trees to expand overall tree canopy. Because care and maintenance of Portland's street trees is the responsibility of the adjacent property owner, rates of homeownership and income also influence the presence and condition of trees in a neighborhood, as the cost of proper maintenance over a tree's lifetime can be a barrier to planting and tree care.

The Irvington neighborhood covers approximately 0.9 square mile and is located in inner NE Portland (Figure 1). Irvington lies within the Willamette River watershed. The Irvington neighborhood is bounded by NE Fremont Street to the north and NE Broadway to the south. NE 7th Avenue defines the western boundary and it is bound by NE 26th Avenue to the east.

Figure 1: Location of Irvington neighborhood in Portland



Irvington includes what was originally the northern section of the William and Elizabeth Irving Donation Land Claim of 1851 and several small adjoining subdivisions. In the 1880s Irvington was cleared farmland. The Oregon Central Railroad reached the east side of the Willamette River in 1868. A railroad bridge was constructed at the current site of the Steel Bridge in 1888. A few years later the streetcar line extended into Albina and communities beyond to the east. Undeveloped land in this area was converted to a grid of blocks and streets for increasing residential neighborhood development as residents moved out from the center of Portland. By 1887, the original claim had been subdivided and a plat filed that essentially became the neighborhood as we know it today. Other influences on the development progress of Irvington include the streetcar line extended along East Broadway in 1899 and the 1905 Lewis and Clark Centennial Exposition.

Irvington holds a federal designation as a member of the National Register of Historic Places, the largest Historic district in Oregon, and one of the largest in the US. The neighborhood is known for its popular Historic Homes Tour, an annual event featuring notable period homes.

Shops, cafes, restaurants, and businesses located on NE Broadway provide the main commercial development to the Irvington neighborhood. Smaller centers are located at NE 24th and Fremont, and NE 15th and Brazee. Irving Park is located in the NW corner of the neighborhood at the intersection of NE Fremont Street and NE 7th Avenue. Irvington School, a K-grade 8 Portland Public School, is located at NE 14th Avenue and Brazee Street. Churches are also scattered throughout the neighborhood.

Tree canopy covers 34% of Irvington, higher than Portland's city-wide canopy level of 29% (Metro 2008). Irvington's population density is higher than city-wide averages, at 15 persons per acre (Table 1). Home ownership is on par with city-wide averages, as 55% of homes in Irvington are owner-occupied. Furthermore, only 27% of Irvington households are considered low-income.

Table 1: Neighborhood and citywide demographics

Demographics (2010 Census)	Irvington	Portland
Area	552 acres	85,376 acres
Population	8,501	583,776
Density	15 persons/acre	7 persons/acre
Race	82% white, 7% black, 5% Hispanic/ Latino, 0.4% Native American, 3% Asian, 0.1% Pacific Islander, 3% mixed race	72% white, 6% black, 9% Hispanic/Latino, 1% Native American, 7% Asian, 1% Pacific Islander, 4% mixed race
% of properties occupied by homeowners	55%	54%
% of low income households	27%	45%

Urban Forest Composition

SPECIES DIVERSITY AND TREE TYPE COMPOSITION

A diverse tree population in terms of species, age, form, and function maximizes urban forest benefits through time while minimizing costs and risk. Maintaining a diverse species mix is a critical way to promote a healthy and resilient urban forest. The conventional metric for evaluating urban forest species diversity is the 10-20-30 rule (Santamour 1990), according to which the urban forest population consists of no more than 10% of one species, 20% of one genus, or 30% of one family. However, this guideline has been found to be inadequate in some cases, leaving cities vulnerable to catastrophic

Planting strips that include maples from the Acer *genus, which is the most abundant street tree genus in Irvington.*

forest loss due to pests and pathogens (Raupp et. al 2006). Considering Portland's temperate climate, where a great variety of trees are able to thrive, limiting this to 5-10-20, as other progressive urban forestry programs have, should be the goal. Trees were identified to the genus or species level and categorized as "tree types" (Appendix A).

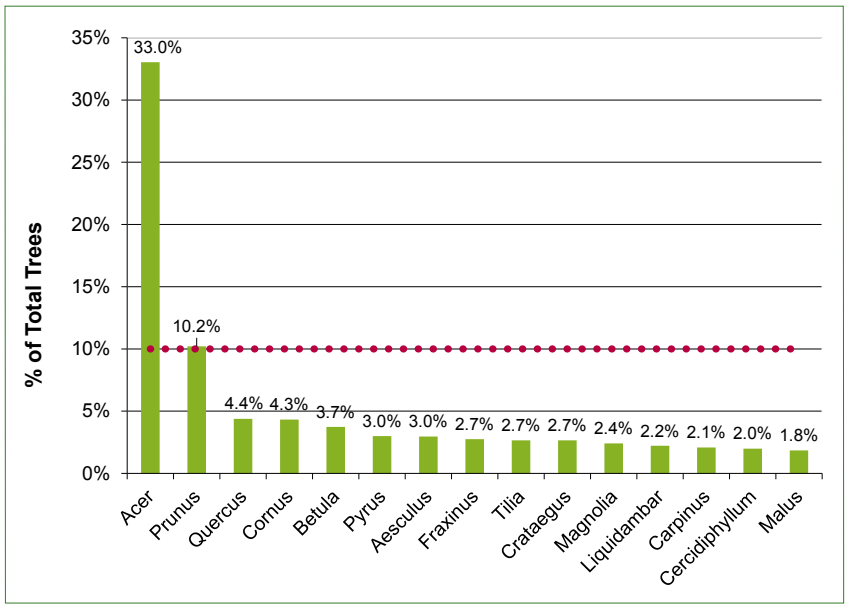
Results

Irvington's public rights-of-way host a wide variety of tree types. The street tree population consists of 5,573 trees of 106 types (Appendix B). Norway maple is the most common tree type, representing 12% of all street trees (Table 2). Red maple, cherry, and other maple (those not identified to species, see Appendix A) are also common, representing 8.2%, 6.4%, and 6.2% of trees, respectively. The most common 15 tree types comprise 67.2% of the resource, leaving the remaining tree types to each represent 4.3% or less of the street tree population.

Table 2: The 15 most abundant street tree types in Irvington

Common Name	Scientific Name	# of Trees	% of Total	Mean DBH
maple, Norway	*Acer platanoides*	671	12.0%	19.3
maple, red	*Acer rubrum*	458	8.2%	14.8
cherry	*Prunus* spp.	354	6.4%	14.4
maple, other	*Acer* spp.	347	6.2%	16.6
dogwood	*Cornus* spp.	241	4.3%	5.6
plum	*Prunus* spp.	210	3.8%	13.8
birch	*Betula* spp.	208	3.7%	16.0
oak, deciduous	*Quercus* spp.	208	3.7%	22.9
pear	*Pyrus* spp.	167	3.0%	11.0
horsechestnut	*Aesculus* spp.	165	3.0%	31.4
ash	*Fraxinus* spp.	153	2.7%	13.2
hawthorn	*Crataegus* spp.	148	2.7%	13.6
linden	*Tilia* spp.	148	2.7%	19.3
maple, paperbark	*Acer griseum*	144	2.6%	5.1
sweetgum	*Liquidambar* spp.	124	2.2%	23.8
all other		1,827	32.8%	12.3
Total		*5,573*	*100.0%*	*14.9*

Figure 2: The 15 most abundant street tree genera in Irvington, with recommended maximum (10%) in red



Ninety genera are represented in the neighborhood. The *Acer* genus comprises a significant portion of the resource at 33%, followed by *Prunus* at 10.2% (Figure 2). All other genera each comprise 4.4% of the resource or less.

Forty families are represented in the neighborhood and the ten most abundant families comprise 83.1% of the resource (Table 3). Sapindaceae and Rosaceae are the most common families and represent 36.2% and 18% of trees, respectively. All other families represent 6% or less of the resource each.

Table 3: The 10 most abundant tree families in Irvington

Family Scientific Name	Tree Types Included in the Family	# of Trees	% of Total
Sapindaceae	boxelder, golden rain tree, horsechestnut, maple	2,016	36.2%
Rosaceae	apple, cherry, crabapple, hawthorn, medlar, mountain-ash, peach, pear, photinia, plum, *Prunus* (other), serviceberry	1,003	18.0%
Betulaceae	birch, hazelnut, hophornbeam, hornbeam	332	6.0%
Cornaceae	dogwood, dove tree, tupelo	273	4.9%
Fagaceae	beech, chestnut, Japanese chinquapin, oak	262	4.7%
Magnoliaceae	magnolia, tulip poplar	188	3.4%
Oleaceae	ash, fringe tree, lilac tree, olive	174	3.1%
Malvaceae	linden, rose of Sharon	149	2.7%
Altingiaceae	sweetgum	124	2.2%
Cercidiphyllaceae	katsura	111	2.0%
all other		941	16.9%
Total		*5,573*	*100.0%*

The Bottom Line

Irvington does not meet the 5-10-20 guideline. Of most concern is that over 54% of the trees belong to only two families, Sapindaceae and Rosaceae. Furthermore, the *Acer* genus has more than 3 times the recommended percentage.

Loss of street trees can have significant impact at the neighborhood scale. Increasing diversity at the genus and family level can help reduce risk and expense due to the introduction of Asian longhorned beetle, emerald ash borer, or other potential pests and pathogens which predominately attack only select genera. To illustrate impact from pests, vulnerable tree types are mapped (Appendix D). Over 50% of all trees in Irvington are susceptible to emerald ash borer, Asian longhorned beetle, Dutch elm disease, or bronze birch borer.

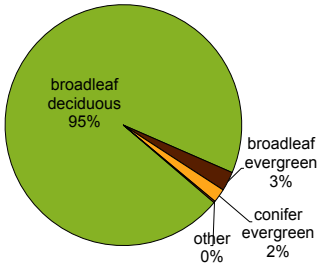
FUNCTIONAL TREE TYPE

Trees are categorized into functional types: broadleaf, conifer, or palm and either deciduous or evergreen. In Portland, where the majority of precipitation falls in winter, evergreens reduce storm water runoff during these wet months, improving water quality in our streams and rivers when this function is most needed. During the dry summer months, many evergreen conifers are less reliant on water availability than broadleaf deciduous trees which require more water to drive photosynthesis. Despite their advantages, conifers are challenging to place in rights-of-way, as they typically require larger spaces and their growth form conflicts with overhead wires and traffic sightlines.

Results

Broadleaf deciduous trees dominate the landscape, accounting for 95% of all street trees in Irvington (Figure 3). Broadleaf evergreens and coniferous evergreens comprise a minimal percentage of Irvington's trees at only 3% and 2% respectively.

Figure 3: Functional tree types



The Bottom Line

The street tree population is dominated by broadleaf deciduous trees. Increasing use of evergreens, both broadleaf and conifer, would enhance certain benefits including reduced storm water runoff, and also provide winter cover and habitat for urban wildlife. Though conifers still need adequate water during establishment, in general they require less water than broadleaf deciduous trees during the increasingly warm and dry Portland summers. Large planting sites with no overhead high voltage power lines provide an opportunity for planting these important trees.

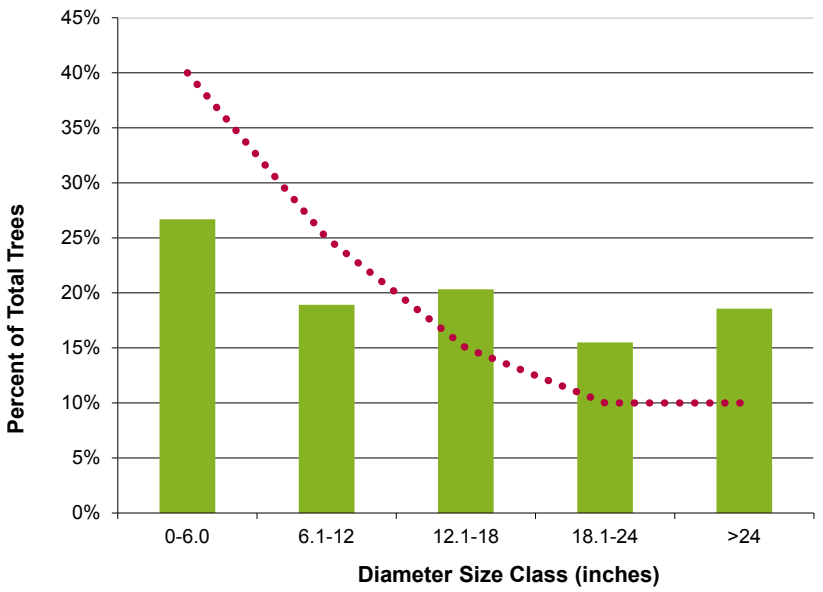
SIZE CLASS DISTRIBUTION

Age diversity ensures the continuity of canopy coverage and benefits through time. Although tree species have different life spans and mature at different sizes, older trees will generally have a larger size, as measured by diameter at breast height (DBH). As trees increase in size and age, the value of the tree and the magnitude of the benefits it provides also increase until the tree nears the end of its lifespan and begins to decline.

The general management principle underlying size class distribution is to maintain a consistent proportion of young trees in the population—recognizing that there will be some level of mortality as trees grow—while also keeping a good distribution of mid to large sized trees. This will ensure a sustainable age class structure and produce maximum urban forest benefits over time.

Trees were categorized into diameter size classes (Figure 4; Appendices C, E, F). Trees that are 0" to 6.0" in diameter represent young trees. Trees that are 6.1" to 18" in diameter represent trees in their midlife, as well as mature, small form trees. Trees that are 18.1" or greater in diameter represent mature trees.

Figure 4: Trees by diameter size class, with ideal distribution in red



Results

Irvington's streets host a wide range of tree sizes from the smallest sapling to the largest tree, a 63.3" DBH elm (*Ulmus* sp.) In Irvington, the greatest proportion of trees are in the medium diameter size classes. Midsize trees account for nearly 40% of the neighborhood inventory with 18.9% percent of all trees that are 0.6 to 12" DBH, and 20.3% that are between 12" and 18". Large trees with DBH larger than 18.0" represent 34.1% of trees and 26.7% are smaller than 6.0" DBH (Figure 4).

Of tree types that represent at least 0.5% of the population, the types with the largest average size DBH are bigleaf maple, silver maple, and horsechestnut, with mean DBH of 38.1", 34.2", and 31.4" respectively (Appendix B).

The Bottom Line

Irvington lacks enough young trees to adequately replace declining older trees. Plantings are needed to increase the proportion of young trees to ensure that as older trees decline, they are replaced by maturing younger trees, thus keeping canopy benefits continuous over time. Quick replacement of removed trees and planting empty spaces will help create a sustainable balance among size classes.

Plating young trees is necessary to offset mortality in Irvington's mature street tree population.

With few small trees, it is vital to address establishment and pruning needs of this vulnerable population. Early maintenance will reduce future maintenance costs and increase the life span of a neighborhood's street trees. Proper pruning of young trees can reduce the likelihood of future hazards and liabilities, such as a limb falling, which is not only potentially costly and dangerous, but can also increase the possibility of decay and mortality in a tree. Making the correct pruning decisions when trees are young ensures the least cost and most benefit to homeowners and the community over a tree's lifetime.

Over 40% of Irvington's trees have survived the establishment period to become midsized trees and are on the right path to providing benefits to the community. Healthy trees in this size class need minimal maintenance if properly established and in good form. However, typical needs may include proper pruning for traffic sign clearance, pedestrians, and vehicles; dead wood and hazard removal; and addressing pests or pathogens.

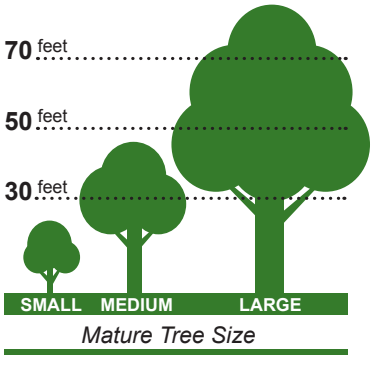
Large trees in Irvington make up over 34% of the population. Many decades have been invested in the growth of these large trees and therefore maintenance and preservation is important. Extra effort is needed to monitor health and site conditions to limit potential hazards and ensure that they can continue to thrive. Each tree type often has species-specific concerns and the assistance of certified arborists is key to providing proper care that will extend the life of these valuable trees.

MATURE TREE FORM DISTRIBUTION

Mature tree size is determined by the height, canopy width, and general form of the tree at maturity; tree types are classified as small, medium, or large. Generally, small trees grow to 30' in height, medium trees grow to 50' in height, and large trees grow over 50' in height (Figure 5). Large form trees also have the potential for greatest longevity, living longer than most small form trees.

While some neighborhoods, due to their design, may not have many spaces big enough to accommodate large form trees, it is important that the spaces that do exist are planted with trees that will grow to be large at maturity. The cost to a community of under planting large spaces can be great over the course of a tree's lifetime. Research has shown that while small and large form trees have similar annual costs of care and maintenance, a large form tree will live four times longer on average and provide over 16 times the benefits over its lifetime (CUFR 2006). In the case of certain benefits, the disparity is much greater; for example, large trees have been found to remove 60-70 times more air pollution annually than small trees (Nowak 1994).

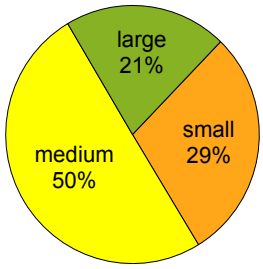
Figure 5: Tree form sizes



Results

Small form trees account for 29% of the resource, medium form trees account for 50% of the resource, and large form trees account for 21% of the resource (Figure 6) in Irvington.

Figure 6: Mature tree size



The Bottom Line

Long lived and large form trees provide substantially more benefits than small and medium form trees. Therefore, planting trees that will be large at maturity helps to ensure that canopy cover and its benefits will be maintained or enhanced even as some trees die or are removed. Irvington's most common large form tree types include deciduous oak, horsechestnut, and linden. Planting, maintenance, and care for young, large form trees will ensure that when they reach maturity, they will provide the most benefits to the community and the environment.

IMPORTANCE VALUE

Another way to evaluate how reliant a community is on a single tree type is importance value. Importance value is a calculation based on relative abundance and relative leaf area. In other words, it accounts for how many trees of the type there are and how much of the neighborhood's canopy they represent at the time of inventory. The value informs us which tree types dominate the urban forest structure. For example, a tree type might represent 10% of a population, but have an importance value of 25 because of its large average size. Conversely, another tree type representing 10% of the population may only have an importance value of 5 if it represents young or small form trees.

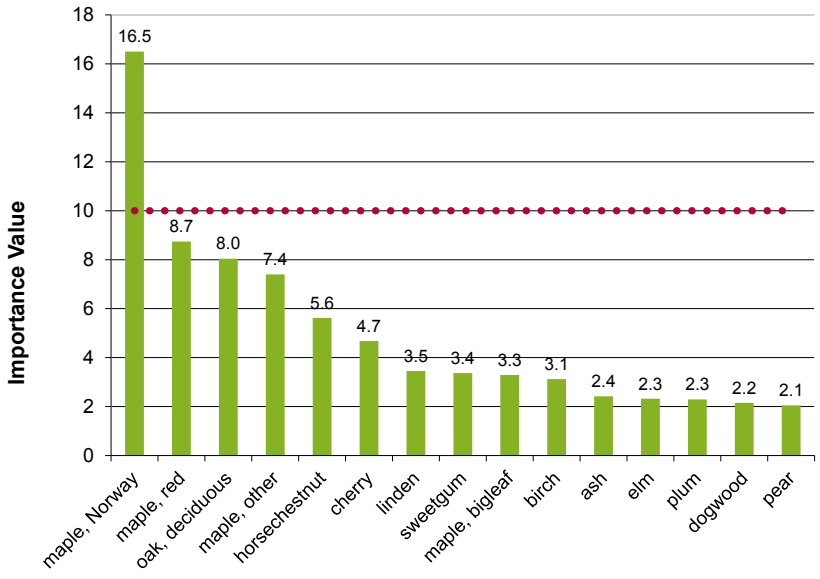
Importance values tell us which tree types provide the bulk of the benefits for a particular snapshot in time and will change through time as trees grow and species composition changes. Reliance on only a few tree types of high importance value is risky, as loss from a pest, pathogen, or a catastrophic event may put excessive strain on the urban forest even though only a single tree type may be affected.

Importance values were calculated using iTree Streets, an urban forest analysis software suite developed by the USDA Forest Service.

Results

Norway maple has the highest importance values of 16.5 (Figure 7). Thus, the Irvington urban forest is reliant on this species due to its current size and abundance in the neighborhood. The next highest importance values are for red maple at 8.7, deciduous oak at 8.0, and maple (other) at 7.4. All other tree types had importance values of 5.6 or less.

Figure 7: Tree types with the highest importance values, with recommended maximum (10) in red



The Bottom Line

Trees with the highest importance values, such as Norway and red

maple should be de-emphasized in future plantings to ensure that the street tree population is less susceptible to loss from a pest or pathogen impacting those tree types. Irvington's heavy reliance on these tree types in the present means that their loss would have a serious impact on the neighborhood's urban forest. Increasing the level of maintenance of these large, mature trees will help prolong their lifespan, reduce hazards, and keep these high value members of the urban forest contributing to the neighborhood.

Tree Condition

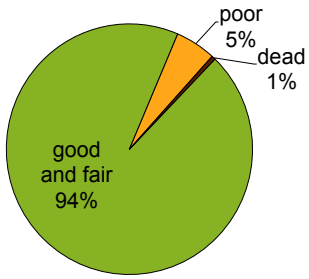
The urban environment is a challenging place for trees to thrive because of limited growing space, compacted soil, poor air quality, and direct damage from vehicles and pedestrians. Tree condition reflects species hardiness, site conditions, and maintenance history. Street trees that are well suited to Portland's climate are able to withstand the challenges of growing in an urban environment, and have been well maintained, are generally the most successful.

Tree condition was assessed by assigning trees to one of four categories: good, fair, poor, or dead. These general ratings reflect whether or not a tree is likely to continue contributing to the urban forest (good and fair trees) or whether the tree is at or near the end of its life (poor and dead trees). Because it was subjective for volunteers to determine the difference between good and fair ratings, these categories are reported together.

Results

The majority of street trees in Irvington, 94.2%, are in good or fair condition, while 5.3% are poor and 0.5% of trees are dead (Figure 8, Appendix G).

Figure 8: Tree condition



Of the most commonly found tree types, the healthiest trees are deciduous oak, linden, and sweetgum, of which more than 99% are rated good or fair (Table 4). In poorest condition are cherry, hawthorn, and horsechestnut, of which, 18.9%, 15.5%, and 11.5% are rated poor, respectively. Interestingly, 42.2% and 34.7% of all trees in Irvington that are rated poor are in the Rosaceae family and Sapindaceae families, respectively. Of poor rated trees, approximately 28% are *Prunus* and 28% are *Acer*.

Table 4: Tree condition for the most abundant tree types

Common Name	Scientific Name	% of Total (# of Trees)	
		Good/Fair	Poor
ash	*Fraxinus* spp.	96.7% (148)	3.3% (5)
birch	*Betula* spp.	97.6% (203)	2.4% (5)
cherry	*Prunus* spp.	81.1% (287)	18.9% (67)
dogwood	*Cornus* spp.	95.4% (230)	4.6% (11)
hawthorn	*Crataegus* spp.	84.5% (125)	15.5% (23)
horsechestnut	*Aesculus* spp.	88.5% (146)	11.5% (19)
linden	*Tilia* spp.	99.3% (147)	0.7% (1)
maple, Norway	*Acer platanoides*	95.8% (643)	4.2% (28)
maple, other	*Acer* spp.	94.5% (328)	5.5% (19)
maple, paperbark	*Acer griseum*	98.6% (142)	1.4% (2)
maple, red	*Acer rubrum*	98.9% (453)	1.1% (5)
oak, deciduous	*Quercus* spp.	99.5% (207)	0.5% (1)
pear	*Pyrus* spp.	98.2% (164)	1.8% (3)
plum	*Prunus* spp.	91.9% (193)	8.1% (17)
sweetgum	*Liquidambar* spp.	99.2% (123)	0.8% (1)

Tree size, and thus life stage, can impact tree condition ratings. In Irvington, 28 trees are dead, with 25% each represented in the 0-3", 6.1-12" and 12.1 to 18" DBH size classes. The young trees likely died due to inadequate watering. Young trees need 15 gallons of

water each week during Portland's dry summer months for the first two years after planting. Establishment of young trees is critical as it is not until trees attain larger sizes that they provide the greatest benefits.

More than 27.9% of poor condition trees are in the largest size class of trees with a DBH greater than 24". While larger, more mature trees naturally decline with age, preventative maintenance including proper pruning (e.g., not topping) can extend their lifespan and reduce their risk of failure.

*Young trees such as this dawn redwood (*Metasequoia glyptostroboides*) need adequate water during establishment.*

The Bottom Line

Large trees in poor condition pose the largest potential risk of failure (i.e., falling apart). Proper early maintenance on young trees, such as structural pruning, is much less expensive than attempting to correct issues in larger trees that have been unmaintained or improperly pruned. Important maintenance activities for young trees include structural pruning to remove co-dominant leaders and pruning trees for branch clearance over sidewalks and roadways to reduce the likelihood of branches being hit by vehicles.

Though only a small portion of the street trees in Irvington are in poor condition, a substantial proportion of the cherry, hawthorn, and horsechestnut are in poor and declining condition. Furthermore, these three tree types are in the Rosaceae or Sapindaceae families, both of which are over represented in Irvington. Therefore, replacement of these trees represents a great opportunity to improve the composition of the Irvington neighborhood's urban forest. All trees rated as poor should be monitored and individually evaluated for potential risk and replacement opportunities.

Planting Site Composition and Stocking Level

Planting site composition varies greatly amongst neighborhoods and this directly impacts a neighborhood's capacity for growing large trees that provide the most canopy coverage and benefits. While some neighborhoods are lucky enough to have inherited wide planting sites and mature trees, many areas of Portland struggle to establish tree canopy in small planting sites, which are challenging spaces for trees to grow due to limited soil and growing space. Understanding a neighborhood's composition and distribution of planting sites allows for a more strategic tree planting effort and informs us of potential challenges to tree planting and tree development within the right-of-way.

PLANTING SITES

Street trees grow in a diverse array of planting sites ranging from traditional grassy strips between curbs and sidewalks, to concrete cutouts, and unimproved areas without curbs or sidewalks. Tree growth is limited by site width; wider sites provide more soil to support growth and more space aboveground to reduce conflicts with sidewalks and streets. Overhead high voltage wires limit the height of trees, as trees will be pruned away from wires for safety.

Planting site sizes are categorized as small, medium, or large based on the width of the planting site and presence of overhead wires. These categories reflect the mature tree size that can be supported by the site. In

other words, small planting sites can support small trees such as dogwoods and snowbells and large planting sites can support large trees such as oaks and elms. Improved planting sites (i.e., with curbs and sidewalks) generally have a clearly defined width while unimproved sites (i.e., without curbs and sidewalks) do not.

Results

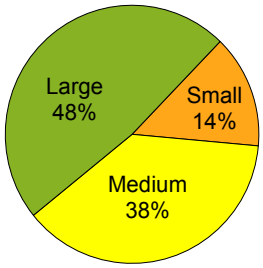
All but one street tree in Irvington are found in improved rights-of-way sites (Table 5). Strips are the most common tree planting site representing 95.6% of site types.

In Irvington, 14% of planting sites where street trees are found are small, 38% are medium, and 48% are large sites (Figure 9).

Table 5: Planting site types

Site Type		# of Trees	% of Total
improved sites	curbtight	63	1.1%
	cutout	158	2.8%
	median	18	0.3%
	strip	5,354	95.6%
	swale	7	0.1%
	Improved Totals	*5,600*	*100.0%*
unimproved sites	other	1	0.0%
	Unimproved Totals	*1*	*0.0%*
Overall		**5,601**	**100.0%**

Figure 9: Planting site sizes



STOCKING LEVEL

Street tree stocking level reflects the percentage of planting spaces that are currently occupied by trees. In Portland, trees are more likely to be planted in large planting sites and improved planting sites. Because this project did not inventory all available planting sites, but only sites where trees are currently growing, data for planting site sizes were supplemented with available planting space data collected by Urban Forestry and the Bureau of Environmental Services (BES) staff between 2009 and 2015 (See Appendix A for methods).

Results

Ideally, stocking level should be near 100%. Irvington's stocking level is 79% for improved sites (Table 6). According to the BES data, 1,401 empty spaces have been identified for tree planting (Appendices J and K). Higher stocking levels are generally observed in larger planting sites and large, improved planting sites are at least 84% stocked.

Table 6: Street tree stocking level

Size Type	Size Size	Planting Site Description	Stocking Level	Available Planting Spaces
improved sites	small	2.5 - 3.9' with or without wires	66%	430
	medium	4.0 - 5.9' with or without wires, ≥6.0' with wires	80%	460
	large	≥6.0' without wires	84%	449
	uncategorized	mixed	77%	62
Total			**79%**	**1,401**

RIGHT TREE IN THE RIGHT PLACE

Selecting an appropriately sized tree for the site is important for maximizing benefits and minimizing avoidable costs. A tree well suited to its location has fewer obstacles to reaching maturity which maximizes the benefits it provides the community and environment over its lifetime. However, an inappropriately sized tree may cost more to maintain, be less healthy, and have a shorter lifespan thereby providing fewer benefits.

A small form tree planted in a large planting site is a missed opportunity because larger trees contribute many times more benefits than do smaller ones. Planting these sites and replacing undersized trees is especially important in neighborhoods that contain few large planting sites to begin with. Although permits and appropriate species selection are required to plant street trees, historically trees may have been planted without regard to appropriate tree selection.

Results

Overall, 40% of trees are planted in sites that are the appropriate size for their type. 46% percent of all trees are too small for their planting site, and 14% of trees are too large for their site (Table 7). Looking closer at only the large sites, 22% of existing trees are small form, and 51% are medium form. This means that a total of 73% of all trees currently planted in large sites are undersized for the site.

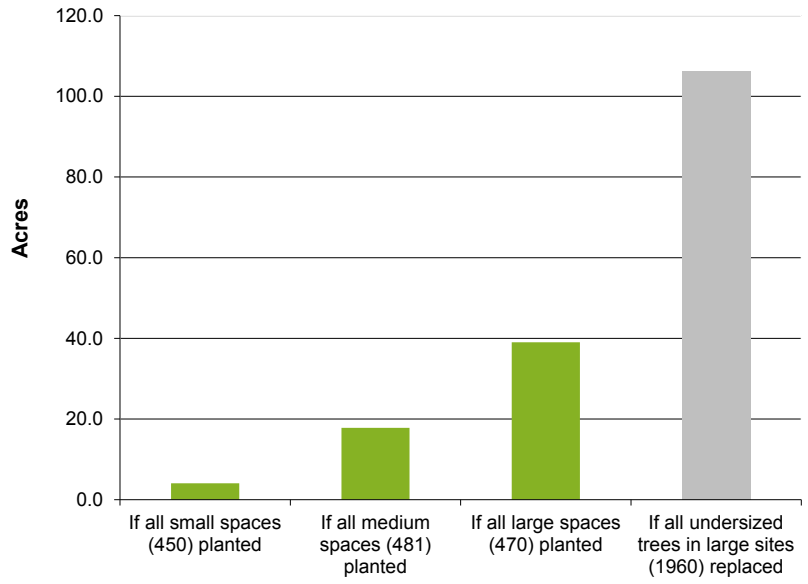
The Bottom Line

Planting all available sites with appropriately sized trees will ensure that trees live to maturity at the least cost to homeowners and the community. Because of the importance of large trees to the urban forest, planting large, empty spaces should be a tree team's top priority, followed by replacing poor condition, undersized trees in large planting sites. In Irvington, this includes an estimated 470 large sites and 103 poor condition, undersized trees in large planting spaces. Planting only the large, empty spaces would yield 39 acres of potential canopy in 30 years (Appendix A, Figure 10). These benefits are nearly nine times greater than if small trees are planted in these large sites.

Table 7: Tree form fit in planting sites

Fit	% of trees	# of trees
Tree form is too small for the site	46%	2,588
Tree form is appropriate size for the site	40%	2,251
Tree form is too big for the site	14%	762
Total	*100%*	*5,601*

Figure 10: Potential acres of tree canopy from planting



How would planting all available spaces affect Irvington's canopy? Planting all sites would provide 61 additional acres. Furthermore, if all of the currently undersized trees in large planting spaces had

been planted with large form trees, this would add another 106 acres of potential canopy. Combined, taking these actions would increase Irvington's canopy cover by 89%!

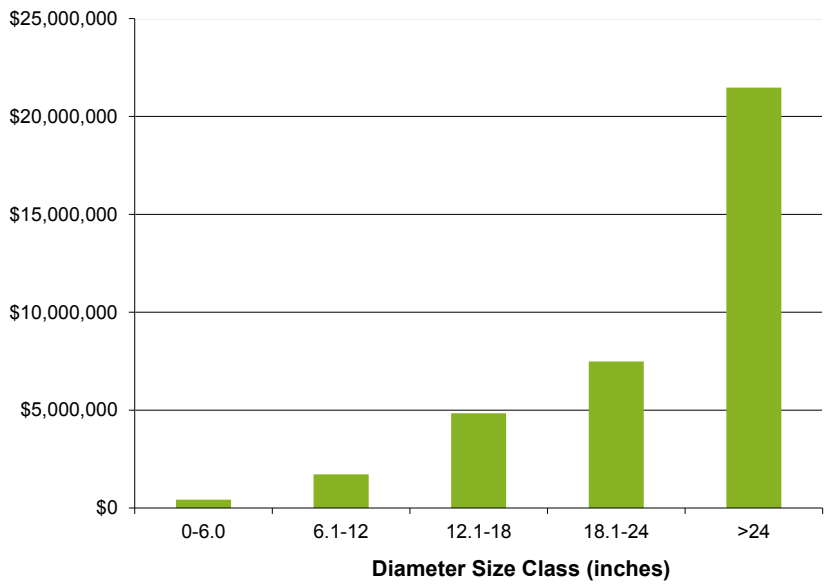
Replacement value

Replacement value is an estimate of the full cost of replacing a tree at its current size and condition, should it be removed. Replacement value is calculated using the tree's current size, along with information on regional species ratings, trunk diameter, and replacement costs. Replacement values were calculated using iTree Streets. Replacement values are generally highest for the largest, most abundant tree types.

Results

The replacement cost of Irvington's street tree population is valued at $35.9 million (Figure 11). The most valuable size classes of trees are those greater than 24" DBH. Because value increases with the size of the tree, even though trees that are over 24" DBH only make up 18.6% of the population, they account for 59.7% of the total replacement value. The tree types with the greatest replacement values are Norway maple ($6,019,446), horsechestnut ($3,069,985), red maple ($2,882,336) and deciduous oak ($2,818,463). These four tree types account for over 41% of the total replacement value.

Figure 11: Replacement values by diameter size class



The Bottom Line

Similar to importance value, high replacement values are both a function of the abundance and size of an existing tree type and do not necessarily represent tree types that should be planted in the future. Healthy, diverse, and resilient urban forests have high replacement values as a whole with no one tree type representing a disproportionate amount. In Irvington, de-emphasizing tree types that are over represented will decrease vulnerability to pests and pathogens in the future. The high replacement value for the neighborhood's largest trees shows the need to care for and protect the largest, most valuable trees in the neighborhood.

Environmental and Aesthetic Benefits

The amount of environmental and aesthetic benefit a tree may provide over its lifetime is a function of its mature size and longevity. Trees with a larger mature size and longer life span such as Douglas-fir or oak will provide significantly greater benefits than small ornamental trees such as dogwoods or snowbells. The calculation indicates the benefits that trees currently provide: as trees grow and the population changes, benefits derived from the various tree types will change within a neighborhood.

Irvington's street tree population was assessed to quantify the dollar value of annual environmental services and aesthetic benefits provided by trees: aesthetic/property value increase, air quality improvement, carbon dioxide reduction, energy savings, and storm water processing. Calculations were made using iTree Streets. The iTree model relies on tree size and species from the inventory, as well as current city pricing for electricity and natural gas, regional benefit prices for air quality, regional storm water interception costs, and the neighborhood's median home resale value (Zillow 2015).

Results

Irvington's street trees provide approximately $1.3 million annually in environmental services and aesthetic benefits (Table 8). An average tree in Irvington provides $239.77 worth of benefits annually.

Table 8: Valuation of annual environmental and aesthetic benefits

Benefits	Total ($)	Total ($) per tree
Aesthetic/Other	$909,776	$162.43
Air Quality	$13,915	$2.48
CO_2	$6,274	$1.12
Energy	$223,290	$39.87
Stormwater	$189,720	$33.87
Total	*$1,342,975*	*$239.77*

Large form trees produce more benefits on average than smaller trees. Of the most common tree types, deciduous oak, horsechestnut, and Norway maple provide the highest annual benefits per tree, at approximately $354- $506 per tree (Table 9). Linden, maple (other), sweet gum, and red maple also provide a high level of annual benefits, ranging between $321 and $350.

Cherry, dogwood, and pear, which are all smaller form trees, provide the least amount of annual benefits, ranging from $116 to $134 annually.

Table 9: Average annual environmental and aesthetic benefits provided by Irvington's most abundant street tree types

Tree Type	Aesthetic/ Property Value	Air Quality	CO_2 Reduction	Energy Savings	Stormwater Processing	Total ($) per tree
oak, deciduous	$318.92	$5.51	$1.93	$88.06	$91.15	$505.57
horsechestnut	$240.40	$5.43	$2.45	$85.82	$82.11	$416.21
maple, Norway	$233.90	$3.97	$1.75	$61.30	$53.11	$354.03
linden	$242.22	$3.33	$1.17	$53.94	$48.91	$349.56
maple, other	$235.94	$3.34	$1.50	$52.07	$43.89	$336.74
sweetgum	$197.04	$3.07	$1.89	$70.53	$58.38	$330.92
maple, red	$230.38	$3.20	$1.13	$50.10	$35.88	$320.69
ash	$204.59	$2.19	$1.08	$33.86	$27.12	$268.84
maple, paperbark	$166.44	$0.65	$0.38	$10.56	$8.72	$186.75
hawthorn	$128.99	$1.55	$2.29	$23.87	$12.85	$169.56
plum	$127.46	$1.50	$2.00	$23.24	$11.90	$166.10
birch	$90.35	$2.01	$0.40	$31.72	$26.22	$150.70
pear	$79.46	$2.27	$0.81	$29.63	$21.91	$134.09
dogwood	$105.25	$0.49	$0.28	$11.20	$8.10	$125.31
cherry	$65.33	$1.85	$0.62	$28.07	$19.95	$115.82

The Bottom Line

Large, empty planting spaces in Irvington represent not only an opportunity to expand canopy, but also represent thousands of dollars in potential environmental and aesthetic benefits to Irvington residents. If Irvington planted all 470 of the available large planting spaces with appropriately sized large form trees, in 30 years they will have provided $910,020 in net benefits. Conversely, if all available large planting spaces were planted with small form trees, over the same period they would have only provided $97,008 in net benefits.

Carefully selecting and planting appropriately sized trees directly impacts the amount of benefits provided by the urban forest. Trees that live longer will always produce more benefits to the community—small form trees have a much shorter lifespan than large form trees and may begin to decline after 30 years, just when large form trees are reaching maturity with decades of benefits to the community to come.

The Future Forest of Irvington

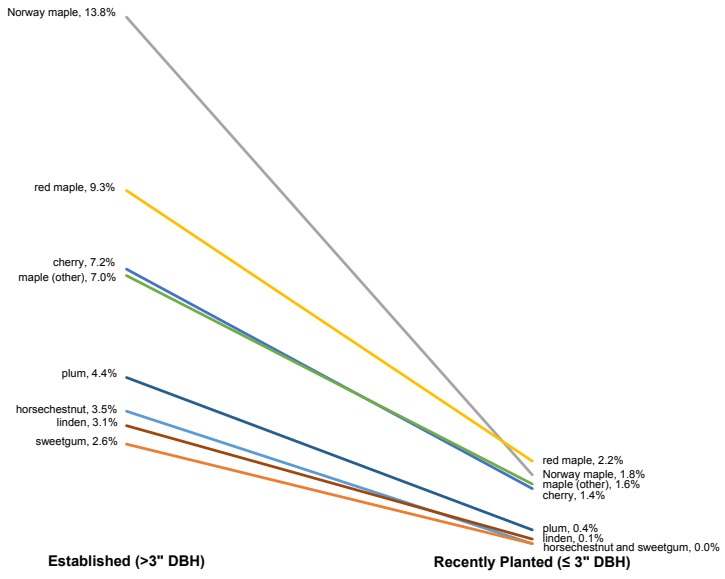
RECENT PLANTING TRENDS

Different species of trees fall in and out of favor over time due to developments in the nursery industry, tree performance, and personal preferences. Portland's street tree population reflects this history, and by comparing the most recently planted trees to the rest of the population we can infer what that trend may mean for the future. Ideally, new plantings will be diverse and show increases in the planting of those large form species which maximize environmental and aesthetic benefits. Established trees (>3"DBH) are compared to recently planted trees (≤ 3" DBH) and those with a change of 2.5% or greater were graphed to illustrate recent trends in planting (Figure 12, 13).

Results

Norway maple, red maple, cherry, and maple (other), which make up nearly a third of Irvington's established street trees as a whole, have been planted far less often in recent years, which will lead to greater long-term species diversity (Figure 12). The steep decline of Norway maple (-12%) is likely due to the listing of the species on the City's nuisance plant list, which means it is no longer permitted for right-of-way planting. Plum, horsechestnut, linden, and sweetgum are also being planted less frequently (-4%, -3.5%, -3.0%, and -2.6% respectively).

Figure 12: Planting trend: Tree types planted less frequently

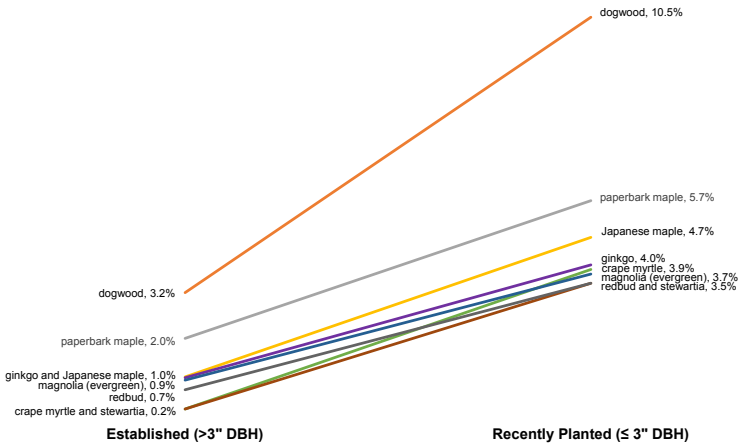


Of the tree types that have increased in number, dogwood, Japanese maple, crape myrtle, and paperbark maple are seeing the largest increases, with changes of +7.2%, +3.7%, +3.7, and +3.6%, respectively. Even with increased plantings of each, all tree types are still well below the recommended 5% threshold for a single species (Table 2, Figure 13). Other species trending up include stewartia (+3.3%), ginkgo (+3%), redbud (+2.8%), and evergreen magnolia (+2.8%).

The Bottom Line

Recent planting trends show an increase in popularity of small form trees, such as dogwood and Japanese maple. Although proportionally not overrepresented in the neighborhood, if these species are located in large sites, it is a missed opportunity for maximizing canopy potential in Irvington. Several maples are decreasing, as are cherry and plum and this is a positive trend as the *Acer* genus and Rosaceae family are both over represented in Irvington.

Figure 13: Planting trend: Tree types planted more frequently



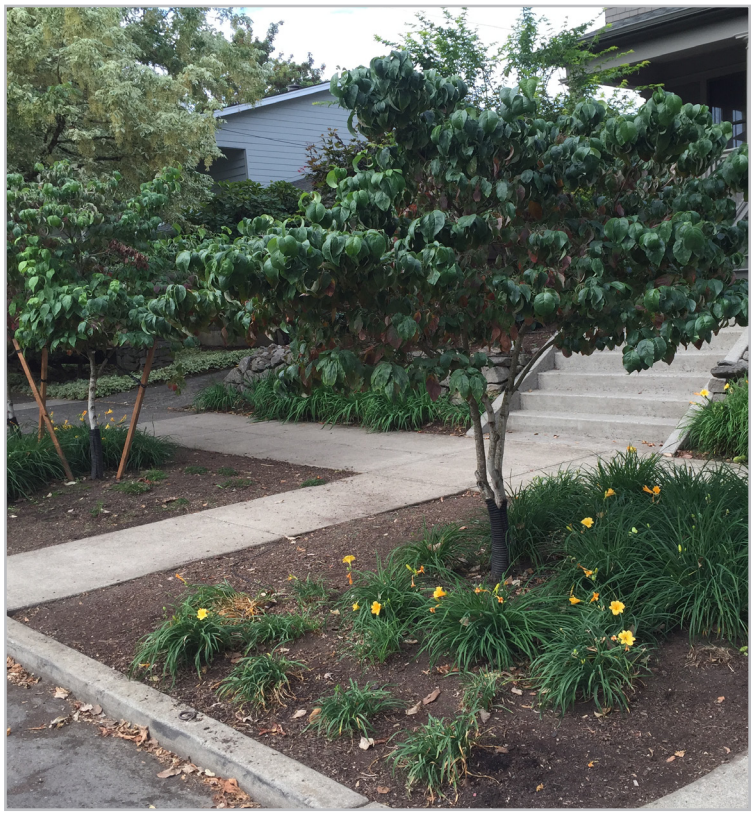
Trees planted more frequently in recent years include diverse species that are new to the Irvington neighborhood. Redbud, evergreen magnolia, and ginkgo are non-existent or very uncommon in the established street tree population. These tree types are all large or medium form trees and will help diversify the neighborhood's urban forest.

TREE COMPOSITION WITHIN LARGE, MEDIUM, AND SMALL PLANTING SITES

Ideally, the mature form of a tree should match the size of its planting site. Appropriately-sized trees maximize benefits to the community while minimizing costly infrastructure conflicts. Table 7 provides an overall picture of undersized trees in Irvington, however a closer look at where the most recently planted trees have been planted can show whether trends in planting are moving in the right direction. The mature form of recently planted trees (≤ 3" DBH) found in large, medium, and small planting sites was compared to established trees (>3" DBH).

Results

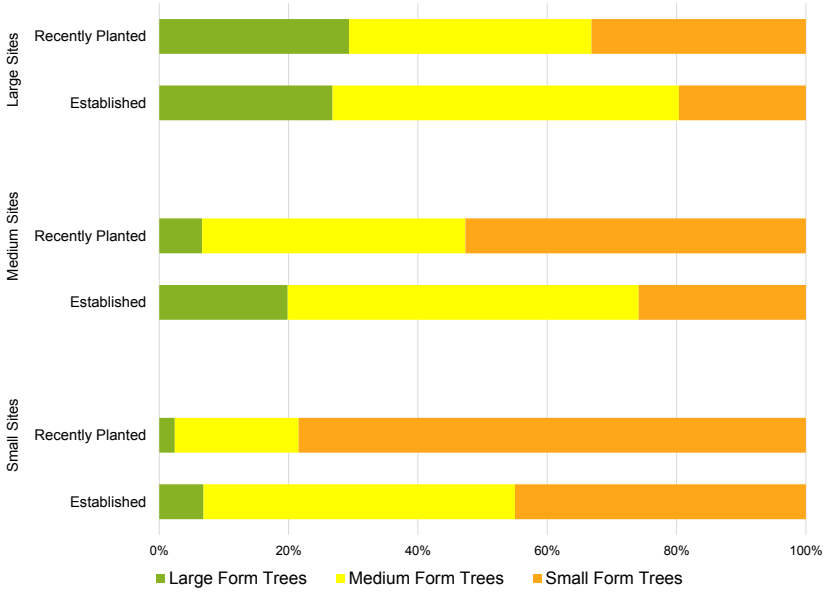
Although large form trees are increasingly planted in large sites, the number of



These small form dogwoods occupy a large planting space that would be better suited to a large form tree, which would provide many times more benefits to Irvington residents over its lifetime.

recently planted medium trees is higher than the number of large trees planted in large sites in Irvington (Figure 14). Small form trees are also increasingly planted in large strips. In medium sites, the planting of large and medium form trees has decreased. Small form trees make up an increasing proportion in small, medium, and large sites, while medium trees have decreased across all three site sizes.

Figure 14: Planting Trend: Mature tree form size shifts



The Bottom Line

Recent plantings in Irvington show that small form trees are increasingly planted in all sites, including large sites. With over 33% of large sites being recently planted with small trees, an increase, and approximately 53% of medium sites still being planted with small trees, this represents a missed opportunity for these sites. Continued efforts to plant appropriately-sized trees in Irvington's rights-of-way will ensure that tree canopy and its benefits are maximized in the neighborhood over the long-term.

Volunteers measure trees and collect data during tree inventory work days in Irvington.

Recommendations

Based on street tree inventory data presented in this report, Urban Forestry staff make the following recommendations for the Irvington neighborhood.

PLANTING FOR DIVERSITY AND SIZE

- Reduce dependence on trees in the Sapindaceae and Rosaceae families, and specifically trees in the *Acer* and *Prunus* genera by planting a diverse array of species, genera, and families. A more diverse urban forest will be more resilient to pests, pathogens, and changing climate conditions. Select species from Urban Forestry's Approved Street Tree Lists (www.portlandoregon.gov/trees/plantinglists).
- Prioritize planting opportunities to plant large, high performing trees that will provide high levels of benefits over their lifetime. These trees would be best planted in the estimated 470 large planting sites (>6' wide without overhead wires) that have been identified for planting (Appendix K).
- Plant trees in all available planting spaces but plant in the smallest spaces last. Trees in small planting spaces provide fewer benefits and are more likely to cause sidewalk and clearance problems in a shorter time frame than if they were planted in larger spaces. However, all plantings help contribute to a neighborhood "tree ethic" and encourage others to plant and maintain street trees. Irvington's street tree stocking level is 79% and 1,401 spaces have been identified for planting street trees (Appendix J).
- Take advantage of existing planting programs, such as low cost trees available through Friends of Trees. These plantings are currently subsidized by the City.

YOUNG TREE ESTABLISHMENT AND MAINTENANCE

- Properly water and establish young trees. Although only 15% of trees are 3" DBH or less, special attention should be paid to this vulnerable population (Appendix E). Small trees represent the future generation of street trees, and early care and training will pay off in future benefits.
- Structurally prune young trees to promote proper form as street trees. This includes removing low limbs for pedestrian and traffic clearance and removing co-dominant leaders. Structural pruning is critical in the first ten years after planting and can prevent future problems and expense. The 27% of trees that are 6" DBH or less should be evaluated for structural pruning needs.
- Educate property owners on how to properly care for young street trees (branch and root pruning, watering, and mulching) in order to reduce and delay future problems and conflicts with infrastructure.

Planting trees like this unusual chitalpa (x Chitalpa tashkentensis) *helps to improve the diversity of the urban forest.*

MATURE TREE PROTECTION AND ADVOCACY

- Maintain and care for large, mature trees. 34% of trees in Irvington are larger than 18" diameter. Trees provide the most benefits as they reach maturity and tree care is also the most expensive for these large trees. Increasing the level of maintenance of large, mature trees will help prolong their lifespan, reduce hazards, and keep these high value members of the urban forest contributing to the neighborhood.
- Seek funding or assistance for low income property owners to care for their mature trees.
- Retain existing large trees in fair and good condition. Benefits are lost when older trees are removed and replaced with smaller and younger tree species, due to the time it takes for young trees to mature.
- Encourage planning for larger trees as redevelopment takes place in the neighborhood. Wider planting sites and cutouts (>6') will result in larger, healthier, longer-lived trees that provide many times more benefits to the community than smaller trees.
- Promote the importance and benefits of large form species and mature trees within the community.

*This evergreen Texas live oak (*Quercus virginiana *var.* fusiformis*) provides canopy benefits year-round.*

REPLACEMENTS - RIGHT TREE, RIGHT PLACE

- Encourage removal and replacement of dead trees and assessment of trees in poor condition. Approximately 5% of Irvington's trees are in poor condition (297 trees) and 0.5% are dead (28 trees) (Appendix G). Further assessment of trees for hazards by a certified arborist can help with prioritization for replacement.
- Encourage replacement of underperforming species, including undersized trees in large rights-of-way, with higher functioning, appropriately sized trees. Consider undersized young trees not yet established and small trees in poor condition for replacement. In large planting sites, 1,960 trees have been identified as being too small for their respective site, 90 of which are in poor condition. Furthermore, approximately 28% each of all trees rated as poor are the Sapindaceae and Rosaceae families. Given that these families are already over represented in the street tree population, these trees should be evaluated on an individual basis for replacement.

*Large trees will grow healthier and larger when planted in the right space, unlike this topped Douglas-fir (*Pseudotsuga menziesii*) growing under high voltage wires.*

Next Steps: Tree Plans and Tree Teams

The experience of participating in a street tree inventory and the findings in this report will help empower the neighborhood to make informed decisions regarding the management and stewardship of the local urban forest. Street trees are a critical component of a community and the 5,601 street trees and 1,401 available planting spaces detailed in this report are a good starting point for the neighborhood Tree Team to begin improving and expanding the urban forest.

NEIGHBORHOOD TREE TEAMS

Volunteers who have participated in the Tree Inventory Project are encouraged to form or join a neighborhood Tree Team. A neighborhood Tree Team is a group of volunteers who are interested in addressing the needs of a neighborhood's urban forest through the activities such as the inventory, education and advocacy, and year-round stewardship events.

TREE PLANS

Urban Forestry knows that local Tree Teams are the best stewards of their urban forest. Having completed the inventory, they can now use these findings to create a Tree Plan—a customized stewardship plan created and executed by neighborhood Tree Teams for their urban forest.

Tree Plans will include a vision statement, goals, objectives, and recommendations for property owners. Using inventory data, Tree Teams can identify the specific needs of their neighborhood's urban forest and create goals that target these needs.

Once a Tree Plan is established, tree teams can take action toward improving their neighborhood's urban forest, with special access to Urban Forestry's staff and resources.

WORKSHOPS

In the year following the inventory, Urban Forestry will support two stewardship events for each neighborhood that completes a street tree inventory, with staff dedicated to assist tree teams in coordinating the events.

Neighborhoods may host a variety of events, including:

- Tree planting in community spaces
- Tree pruning, with a focus on structural pruning for young trees
- Young tree care
- Educational tree tours and lessons on topics such as species selection for diversity, invasive species recognition and removal, heritage trees, and addressing pests and pathogens
- Programs customized for the neighborhood based upon inventory findings

*Young street trees like this silverbell (*Halesia monticola*) benefit greatly from structural pruning in the first ten years after planting.*

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Appendices

Appendix A: Methods

Street trees are defined in this project as woody plants in the public right-of-way with a single or few trunks and a minimum mature size of 15'. In the summer of 2014 and 2015, street trees adjacent to every tax lot within the neighborhood boundaries were inventoried by trained volunteers and Urban Forestry staff.

DATA COLLECTED

Data collected included: tree type identified to species or genus, tree condition, location, size (diameter at breast height), planting site width, planting site type, and presence of overhead high voltage lines.

Tree type: Trees were identified to the genus or species. Six maples were identified to the species level: bigleaf (*Acer macrophyllum*), Japanese (*A. palmatum*), Norway (*A. platanoides*), paperbark (*A. griseum*), red (*A. rubrum*) and silver (*A. saccharinum*) maples. All other maple species were identified as "maple, other." All dead trees were listed as "unknown" tree type, as identification of these plants was uncertain.

Tree condition: Trees were rated as good, fair, poor, or dead. These general ratings reflect whether or not a tree is likely to continue contributing to the urban forest (good and fair trees) or whether the tree is at or near the end of its life (poor and dead trees). The following guidelines were used:

Good: The tree has strong structure and is healthy and vigorous with no apparent problems. Trunks are solid with no bark damage and the crown is full. Roots show no signs of heaving or visible crossing, and there are no major wounds, decay, conks, or cavities.

Fair: The tree is in average condition. Structural problems may be present, including results of pruning for high voltage electrical lines. Tree may have dead branches and some canopy loss. Wounds are minimal and there is no major decay.

Poor: The tree is in a general state of decline as indicated by major wounds, root heaving, dead limbs resulting in major canopy loss, and/or visible signs of decay indicated by major rot or fungal growth.

Dead: The tree is dead with no live leaves. Dead trees were excluded from data analysis, with the exception of tree condition statistics and total number of trees inventoried.

Tree size: Diameter at breast height (4.5' above ground) was measured with a diameter tape. Measurements of trees with branches, forks, or swelling at 4.5' were taken lower on the tree so a representative size was obtained. Trees with 3 or fewer multiple stems were measured individually and Urban Forestry staff made final diameter calculations using the formula $\sqrt{(x^2+y^2+z^2)}$. Trees with greater than 3 multiple stems were measured below branching.

Planting site type: Planting site types were placed into one of the following categories.

Improved sites:
Curbtight: The curb and sidewalk are continuous, and tree is planted adjacent to tax lot.
Cutout: The site is a concrete cutout, also called a tree pit or tree well.
Median: The site is in the middle of the street separated by a curb.
Planting strip: The tree is a planting strip between a curb and a sidewalk.
Swale: The tree is in the middle of a bioswale designed for storm water capture.

Unimproved sites:
Curb only: The site has a curb but no sidewalk.
No curb or sidewalk: The site has no curb or sidewalk.
Other: Sites not falling under above scenarios.

Planting site width: Planting site width was measured for all improved site types except curbtight areas. Planting strips were measured from the inside of the curb to the beginning of the sidewalk and cutouts, medians, and swales were measured from inside edge to inside edge perpendicular to the street. No widths were taken for unimproved planting site types or curbtight areas.

High voltage wires: The presence of high voltage wires above the planting space was recorded.

Stocking level: Planting space size and availability is subject to a number of guidelines, including width of the planting site, presence/absence of high voltage power lines, and distance from conflicts (property lines, stop signs, and underground utilities). Because this project did not inventory all available planting sites, but only sites where trees are currently growing, data for planting site sizes were supplemented with available planting space data collected by Urban Forestry and the Bureau of Environmental Services between 2009 and 2015. These data were compared with existing tree data collected at the same time and used to calculate stocking level. Some industrial, commercial, and multi-family residential areas may have been excluded in the analysis, making this a conservative estimate of available sites.

DATA COLLECTION METHODS

Volunteer neighborhood coordinators recruited volunteers to conduct street tree inventories during work days. Volunteers interested in being inventory team leaders attended a half-day training to learn to identify tree species and site conditions, and how to collect and record data.

During work days, team leaders were paired with novice volunteers to collect data in a three to four block area. Groups were given a clipboard containing a map, data entry sheets, tree type abbreviations, and a list of trees planted by Friends of Trees in the neighborhood. Volunteers wore safety vests and carried a 2-sided diameter/measuring tape for measuring tree size and site width, a tree identification book, and bags for collecting samples.

In addition to Urban Forestry staff, one or more volunteer arborists-on-call were available on inventory work days to assist volunteers with questions. Accuracy was stressed as highly important, and volunteers utilized the arborist-on-call to verify species identification as questions arose. Data were collected on paper maps and forms, and later digitized in ArcGIS by Urban Forestry staff and trained volunteers.

Accuracy of volunteer-collected data was checked by Urban Forestry staff and corrections were made as necessary. Remaining areas not completed during inventory work days were inventoried by volunteer team leaders or staff. A 10% sample of the final data found species identifications to be more than 95% accurate.

CALCULATION OF BENEFITS AND CANOPY PROJECTION

Projected benefits were calculated using 30-year estimates of average annual net benefits provided in the Western Washington and Oregon Community Tree Care Guide (McPherson et al. 2002). Projected canopy cover estimates assume the mature spread of small, medium, and large trees to 20'x 20', 40' x 40', and 60' x 60', respectively. In some cases the data for available planting spaces from the Bureau of Environmental Services (BES) included planting sites that were not categorized by size. Therefore, for the purposes of calculating projected benefits, these spaces were assumed to have a similar proportion of small, medium, and large sites, as were categorized by BES in the neighborhood.

Appendix B: Street trees of Irvington by tree type

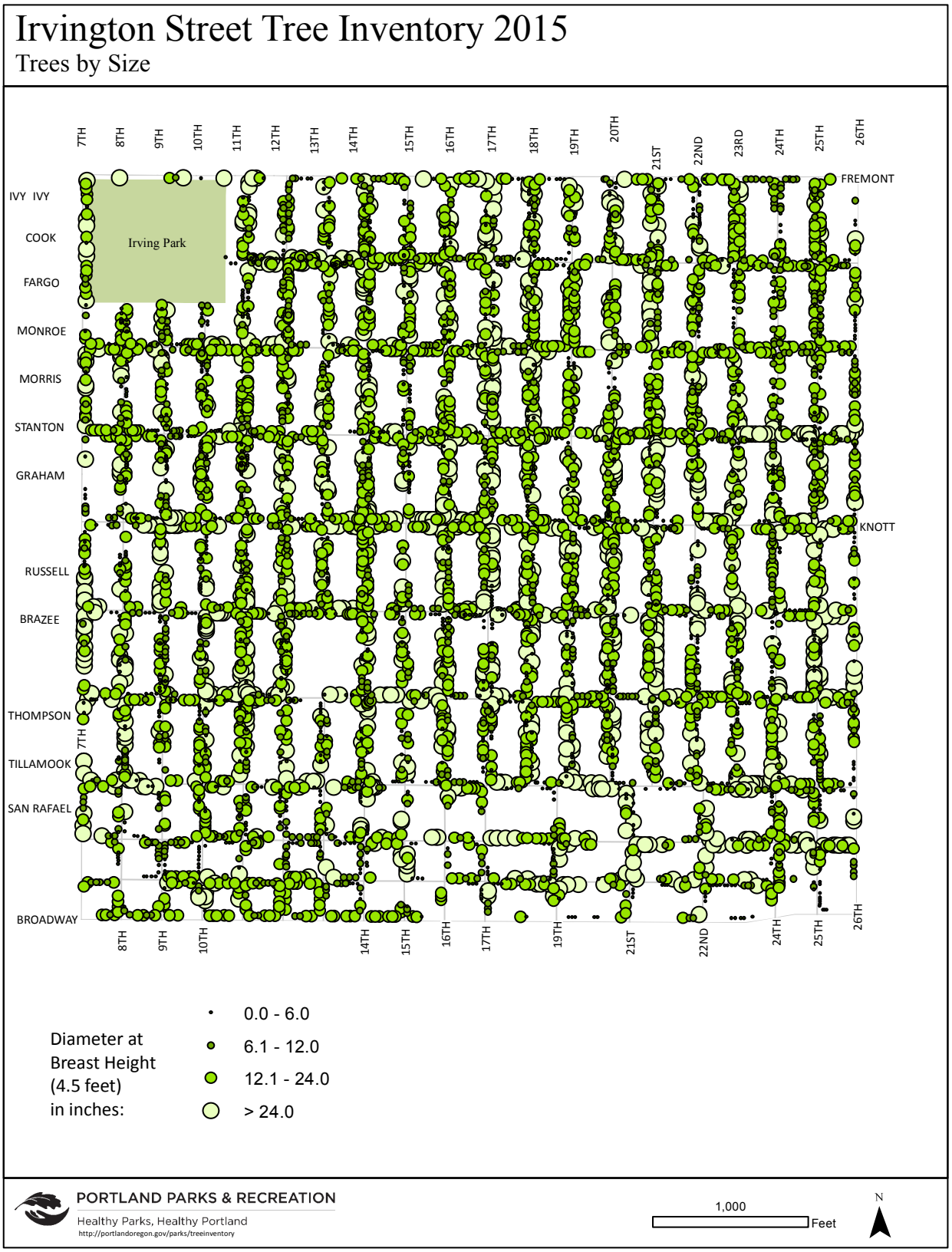
Common Name	Scientific Name	Family	# of Trees	% of Total	Mean DBH
Amur maackia	*Maackia amurensis*	Leguminosae	2	0.0%	1.6
apple	*Malus domestica*	Rosaceae	18	0.3%	6.1
arborvitae	*Thuja arborvitae*	Cupressaceae	3	0.1%	12.4
ash	*Fraxinus* spp.	Oleaceae	153	2.7%	13.2
azara	*Azara* spp.	Salicaceae	1	0.0%	2.0
beech	*Fagus* spp.	Fagaceae	16	0.3%	9.4
birch	*Betula* spp.	Betulaceae	208	3.7%	16.0
black locust	*Robinia pseudoacacia*	Leguminosae	4	0.1%	22.4
boxelder	*Acer negundo*	Sapindaceae	16	0.3%	19.2
camellia	*Camellia* spp.	Theaceae	1	0.0%	2.5
camphor tree	*Cinnamomum* spp.	Lauraceae	2	0.0%	6.4
cascara	*Rhamnus purshiana*	Rhamnaceae	10	0.2%	1.3
catalpa	*Catalpa* spp.	Bignoniaceae	21	0.4%	24.6
cedar	*Cedrus* spp.	Pinaceae	5	0.1%	20.4
cherry	*Prunus* spp.	Rosaceae	354	6.4%	14.4
chestnut	*Castanea* spp.	Fagaceae	1	0.0%	38.5
Chinese pistache	*Pistacia chinensis*	Anacardiaceae	13	0.2%	5.8
chitalpa	*x Chitalpa tashkentensis*	Bignoniaceae	2	0.0%	1.8
crabapple	*Malus* spp.	Rosaceae	85	1.5%	6.1
crape myrtle	*Lagerstroemia indica*	Lythraceae	41	0.7%	2.7
cypress	*Cupressus* spp.	Cupressaceae	6	0.1%	5.1
dawn redwood	*Metasequoia glyptostroboides*	Taxodiaceae	4	0.1%	4.3
dogwood	*Cornus* spp.	Cornaceae	241	4.3%	5.6
Douglas-fir	*Pseudotsuga menziesii*	Pinaceae	11	0.2%	28.3
dove tree	*Davidia involucrata*	Cornaceae	1	0.0%	8.8
elderberry	*Sambucus* spp.	Caprifoliaceae	1	0.0%	6.0
elm	*Ulmus* spp.	Ulmaceae	62	1.1%	24.4
eucalyptus	*Eucalyptus* spp.	Myrtoideae	9	0.2%	11.9
false cypress	*Chamaecyparis* spp.	Cupressaceae	16	0.3%	9.4
fig	*Ficus* spp.	Moraceae	11	0.2%	4.0
fir	*Abies* spp.	Pinaceae	3	0.1%	7.7
fringe tree	*Chionanthus* spp.	Oleaceae	3	0.1%	1.1
giant sequoia	*Sequoiadendron giganteum*	Taxodiaceae	1	0.0%	45.3
ginkgo	*Ginkgo biloba*	Ginkgoaceae	81	1.5%	6.6
glorybower	*Clerodendrum* spp.	Verbenaceae	32	0.6%	4.1
golden chain tree	*Laburnum* spp.	Leguminosae	2	0.0%	2.1
golden rain tree	*Koelreuteria paniculata*	Sapindaceae	10	0.2%	7.9
hackberry	*Celtis occidentalis*	Cannabaceae	4	0.1%	1.4
hardy rubber tree	*Eucommia ulmoides*	Eucommiaceae	1	0.0%	11.2
hawthorn	*Crataegus* spp.	Rosaceae	148	2.7%	13.6
hazelnut	*Corylus* spp.	Betulaceae	5	0.1%	4.5

Common Name	Scientific Name	Family	# of Trees	% of Total	Mean DBH
hemlock	*Tsuga* spp.	Pinaceae	2	0.0%	15.0
hickory	*Carya* spp.	Juglandaceae	1	0.0%	43.5
holly	*Ilex* spp.	Aquifoliaceae	7	0.1%	16.5
honey locust	*Gleditsia triacanthos*	Leguminosae	25	0.4%	9.6
hophornbeam	*Ostrya* spp.	Betulaceae	3	0.1%	1.4
hornbeam	*Carpinus* spp.	Betulaceae	116	2.1%	16.1
horsechestnut	*Aesculus* spp.	Sapindaceae	165	3.0%	31.4
incense cedar	*Calocedrus decurrens*	Cupressaceae	1	0.0%	2.8
Japanese chinquapin	*Castanopsis cuspidata*	Fagaceae	1	0.0%	9.8
juniper	*Juniperus* spp.	Cupressaceae	1	0.0%	3.1
katsura	*Cercidiphyllum japonicum*	Cercidiphyllaceae	111	2.0%	7.9
Kentucky coffeetree	*Gymnocladus dioica*	Leguminosae	1	0.0%	11.7
lilac tree	*Syringa reticulata*	Oleaceae	14	0.3%	6.9
linden	*Tilia* spp.	Malvaceae	148	2.7%	19.3
madrone	*Arbutus menziesii*	Ericaceae	1	0.0%	15.2
magnolia, deciduous	*Magnolia* spp.	Magnoliaceae	58	1.0%	6.6
magnolia, evergreen	*Magnolia* spp.	Magnoliaceae	76	1.4%	6.4
maple, bigleaf	*Acer macrophyllum*	Sapindaceae	85	1.5%	38.1
maple, Japanese	*Acer palmatum*	Sapindaceae	88	1.6%	5.0
maple, Norway	*Acer platanoides*	Sapindaceae	671	12.0%	19.3
maple, other	*Acer* spp.	Sapindaceae	347	6.2%	16.6
maple, paperbark	*Acer griseum*	Sapindaceae	144	2.6%	5.1
maple, red	*Acer rubrum*	Sapindaceae	458	8.2%	14.8
maple, silver	*Acer saccharinum*	Sapindaceae	32	0.6%	34.2
medlar	*Mespilus* spp.	Rosaceae	1	0.0%	9.4
monkey puzzle	*Araucaria araucana*	Araucariaceae	2	0.0%	0.0
mountain-ash	*Sorbus* spp.	Rosaceae	10	0.2%	12.5
myrtlewood	*Umbellularia californica*	Lauraceae	1	0.0%	1.3
oak, deciduous	*Quercus* spp.	Fagaceae	208	3.7%	22.9
oak, evergreen	*Quercus* spp.	Fagaceae	36	0.6%	9.1
olive	*Olea* spp.	Oleaceae	4	0.1%	8.3
palm	*Trachycarpus* spp.	Arecaceae	7	0.1%	2.6
peach	*Prunus persica*	Rosaceae	2	0.0%	6.4
pear	*Pyrus* spp.	Rosaceae	167	3.0%	11.0
pecan	*Carya illinoinensis*	Juglandaceae	1	0.0%	18.3
Persian ironwood	*Parrotia persica*	Hamamelidaceae	45	0.8%	4.2
persimmon	*Diospyros* spp.	Ebenaceae	4	0.1%	1.5
photinia	*Photinia* spp.	Rosaceae	3	0.1%	10.4
pine	*Pinus* spp.	Pinaceae	30	0.5%	12.1
planetree	*Platanus* spp.	Platanaceae	59	1.1%	30.4
plum	*Prunus* spp.	Rosaceae	210	3.8%	13.8
poplar	*Populus* spp.	Salicaceae	15	0.3%	3.4

Common Name	Scientific Name	Family	# of Trees	% of Total	Mean DBH
Prunus, other	*Prunus* spp.	Rosaceae	3	0.1%	6.1
redbud	*Cercis* spp.	Leguminosae	62	1.1%	4.4
rose of Sharon	*Hibiscus syriacus*	Malvaceae	1	0.0%	4.6
serviceberry	*Amelanchier* spp.	Rosaceae	2	0.0%	1.8
silverbell	*Halesia* spp.	Styracaceae	4	0.1%	3.9
smoketree	*Cotinus* spp.	Anacardiaceae	24	0.4%	3.5
snowbell	*Styrax* spp.	Styracaceae	56	1.0%	3.8
sourwood	*Oxydendrum arboreum*	Ericaceae	7	0.1%	0.8
spruce	*Picea* spp.	Pinaceae	14	0.3%	9.2
stewartia	*Stewartia pseudocamellia*	Theaceae	38	0.7%	2.2
strawberry tree	*Arbutus* spp.	Ericaceae	1	0.0%	6.7
sweetgum	*Liquidambar* spp.	Altingiaceae	124	2.2%	23.8
tea tree	*Leptospermum* spp.	Myrtaceae	2	0.0%	3.0
tree-of-heaven	*Ailanthus altissima*	Simaroubaceae	4	0.1%	10.6
tulip poplar	*Liriodendron tulipifera*	Magnoliaceae	54	1.0%	30.3
tupelo	*Nyssa* spp.	Cornaceae	31	0.6%	5.3
walnut	*Juglans* spp.	Juglandaceae	71	1.3%	18.2
Western redcedar	*Thuja plicata*	Cupressaceae	9	0.2%	27.7
willow	*Salix* spp.	Salicaceae	12	0.2%	8.4
wingnut	*Pterocarya* spp.	Juglandaceae	31	0.6%	26.7
witch hazel	*Hamamelis* spp.	Hamamelidaceae	3	0.1%	6.2
yellow wood	*Cladrastis kentukea*	Leguminosae	8	0.1%	2.3
zelkova	*Zelkova serrata*	Ulmaceae	43	0.8%	6.8
Total			*5,573*	*100.0%*	*14.9*

Volunteers measure sites and trees and collect data during several tree inventory work days in Irvington.

Appendix C: Street trees of Irvington by size



Appendix D: Vulnerability to key pests

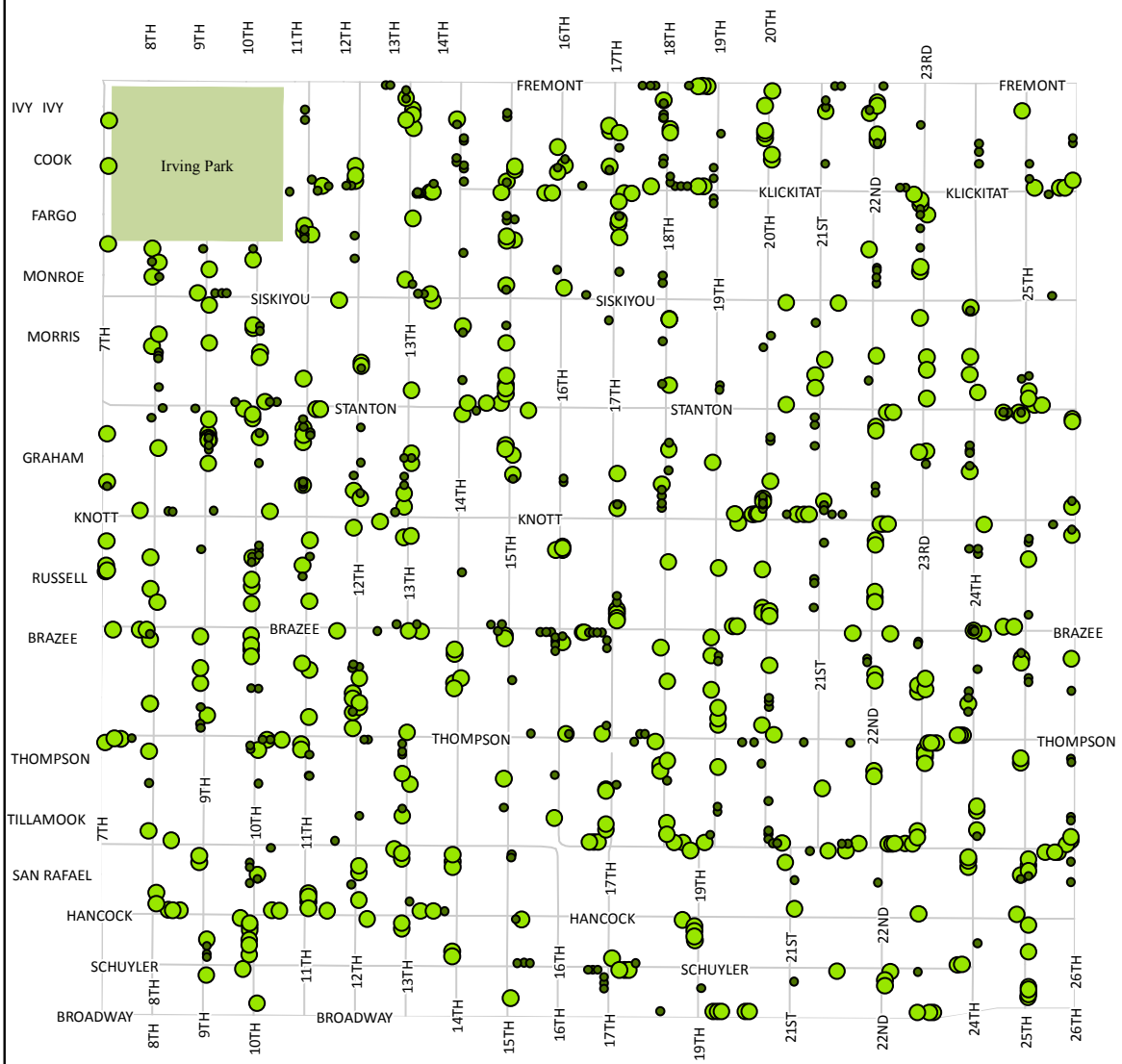
Irvington Street Tree Inventory 2015

Vulnerabilty to key pests

Appendix E: Young street trees (trees ≤ 3” DBH)

Irvington Street Tree Inventory 2015

Young street trees (trees ≤ 3” DBH)



Diameter at Breast Height (4.5 feet) in inches:

- 0.0 - 1.5
- 1.6 - 3.0

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http://portlandoregon.gov/parks/treeinventory

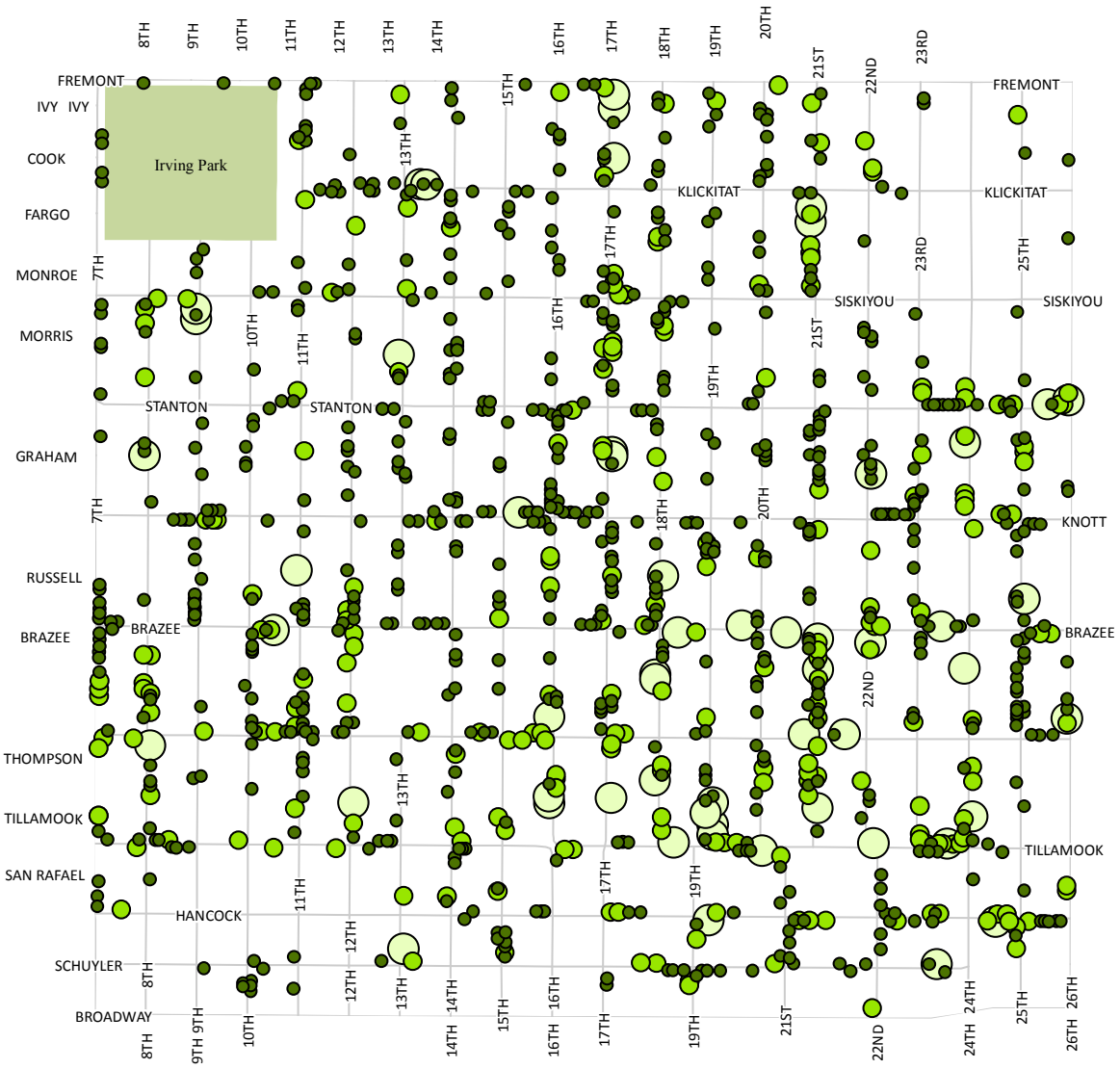
1,000 Feet

N

Appendix F: Large street trees (trees > 24” DBH)

Irvington Street Tree Inventory 2015

Large street trees (trees > 24" DBH)



Diameter at Breast Height (4.5 feet) in inches:

- 24.1 - 36.0
- 36.1 - 48.0
- > 48.0

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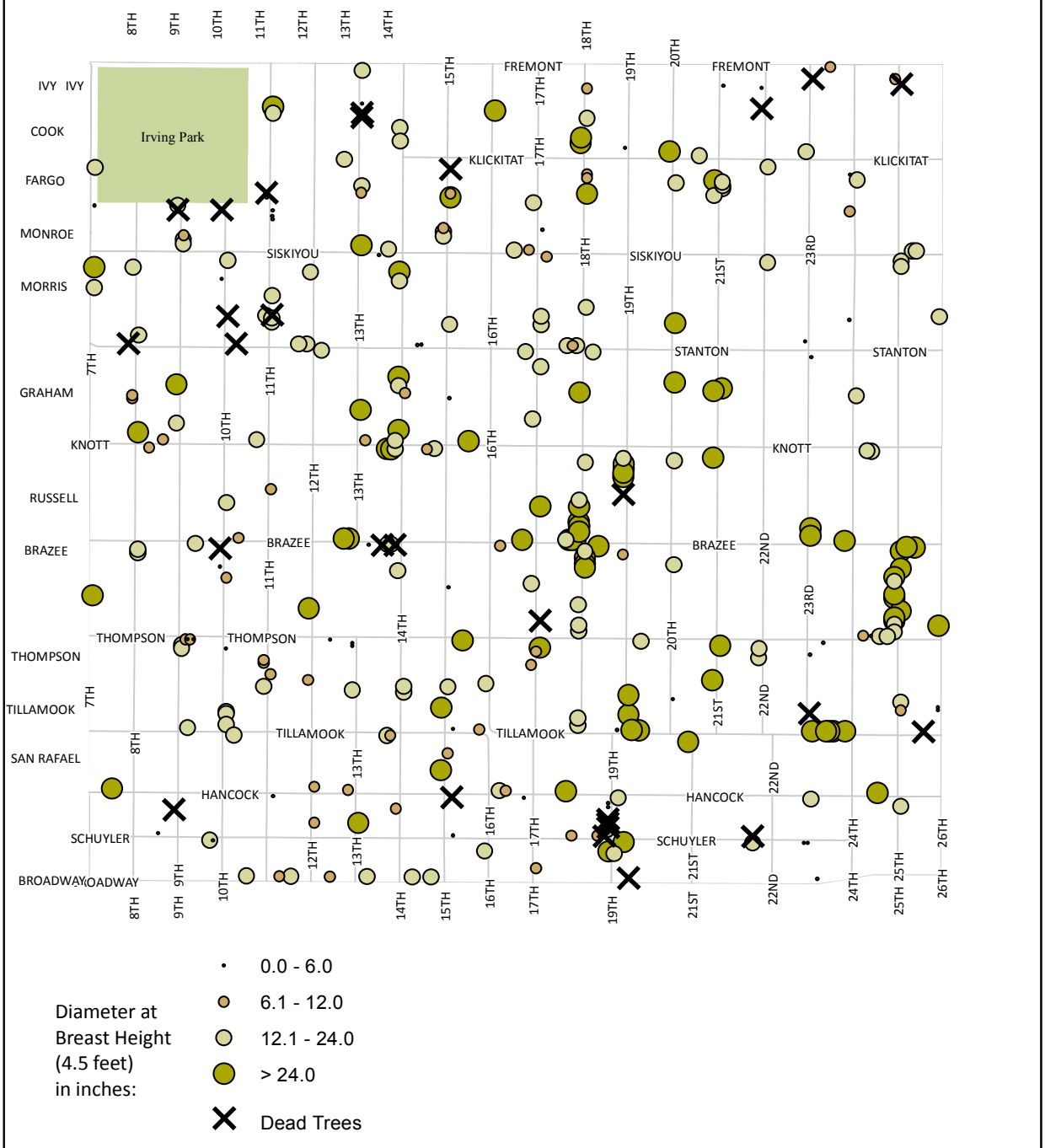
1,000 Feet

N

Appendix G: Poor and dead street trees

Irvington Street Tree Inventory 2015

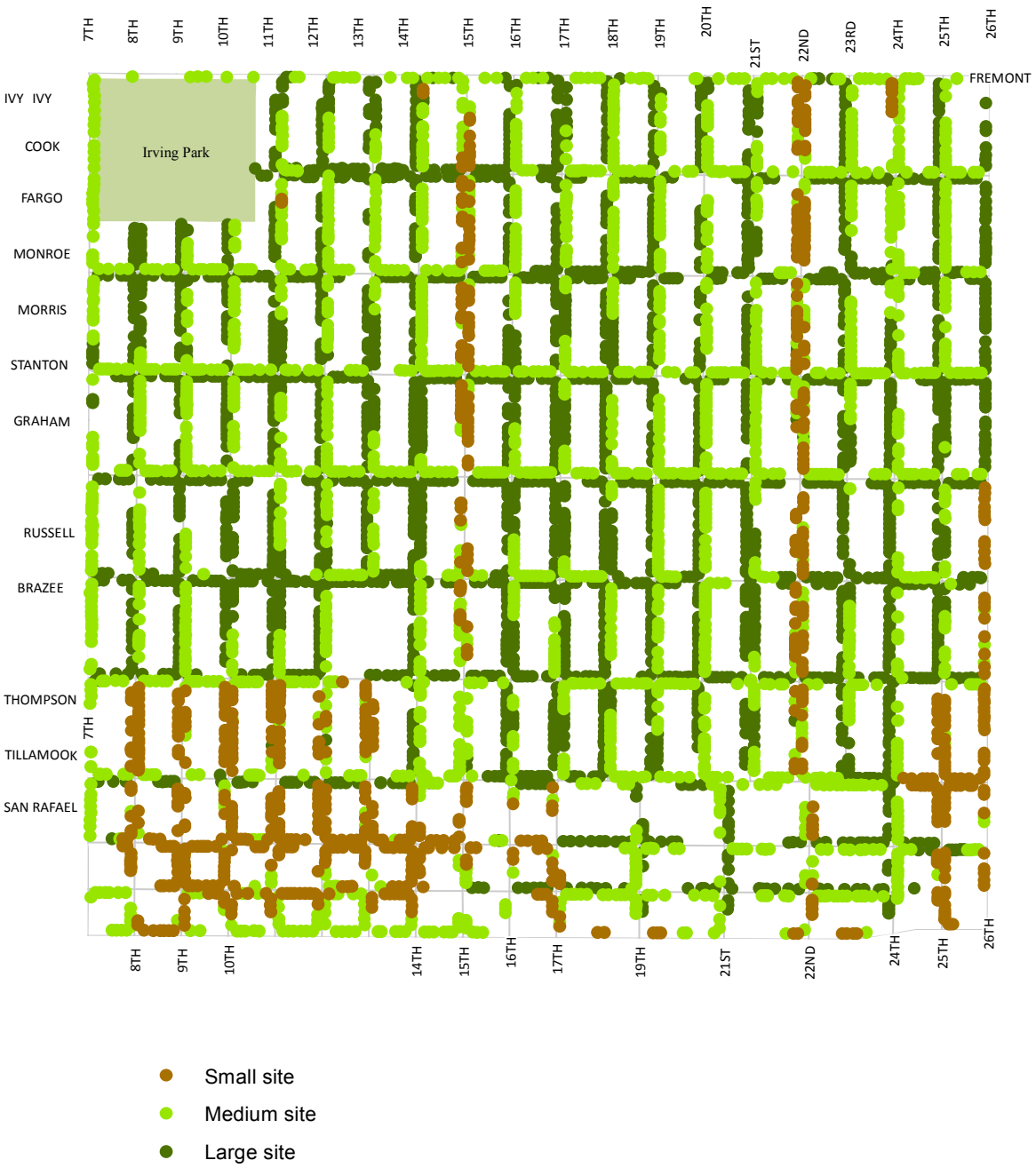
Poor and dead street trees



Appendix H: Planting site sizes

Irvington Street Tree Inventory 2015

Planting site sizes



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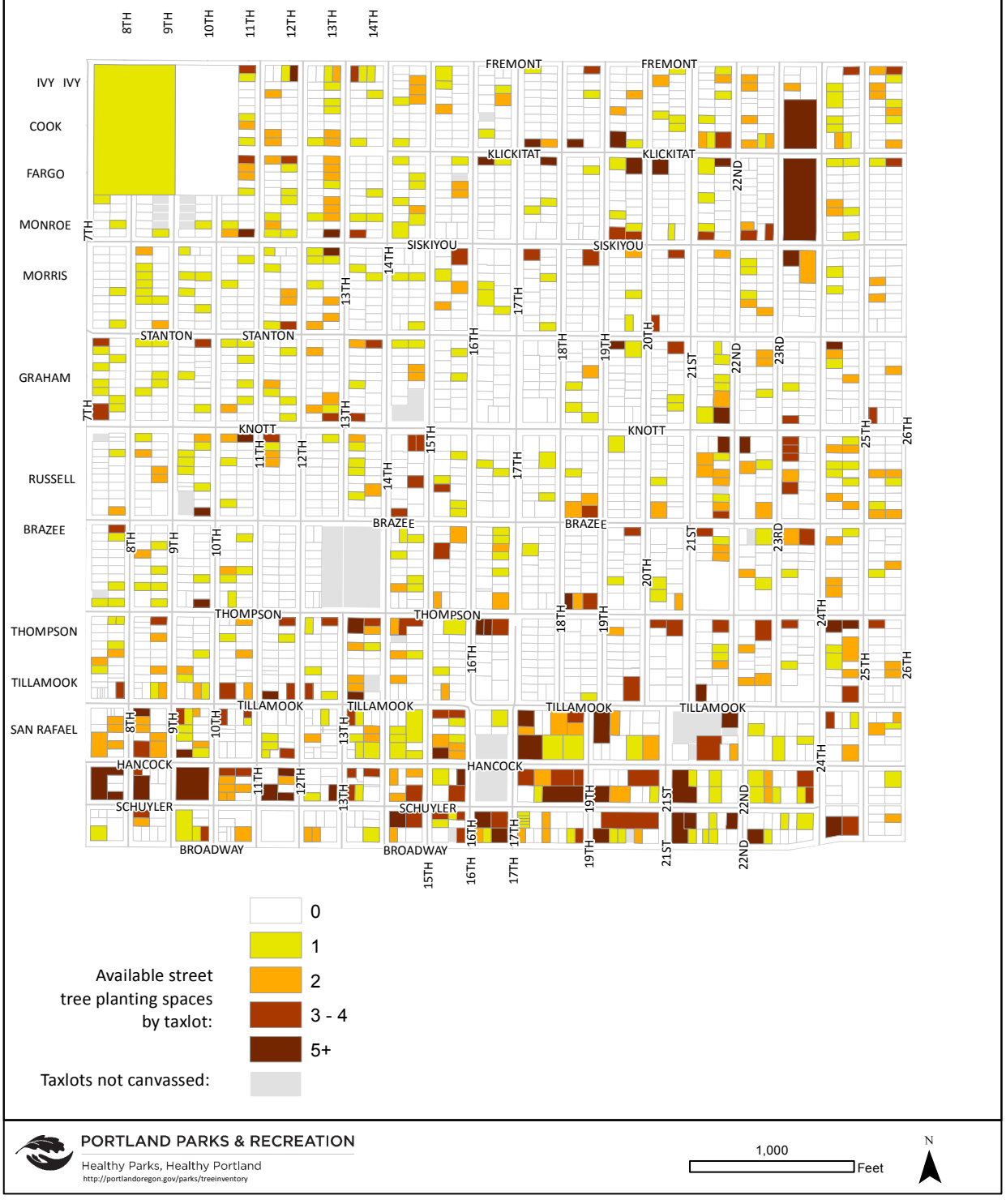
1,000 Feet

N

Appendix I: Available street tree planting sites

Irvington Street Tree Inventory 2015

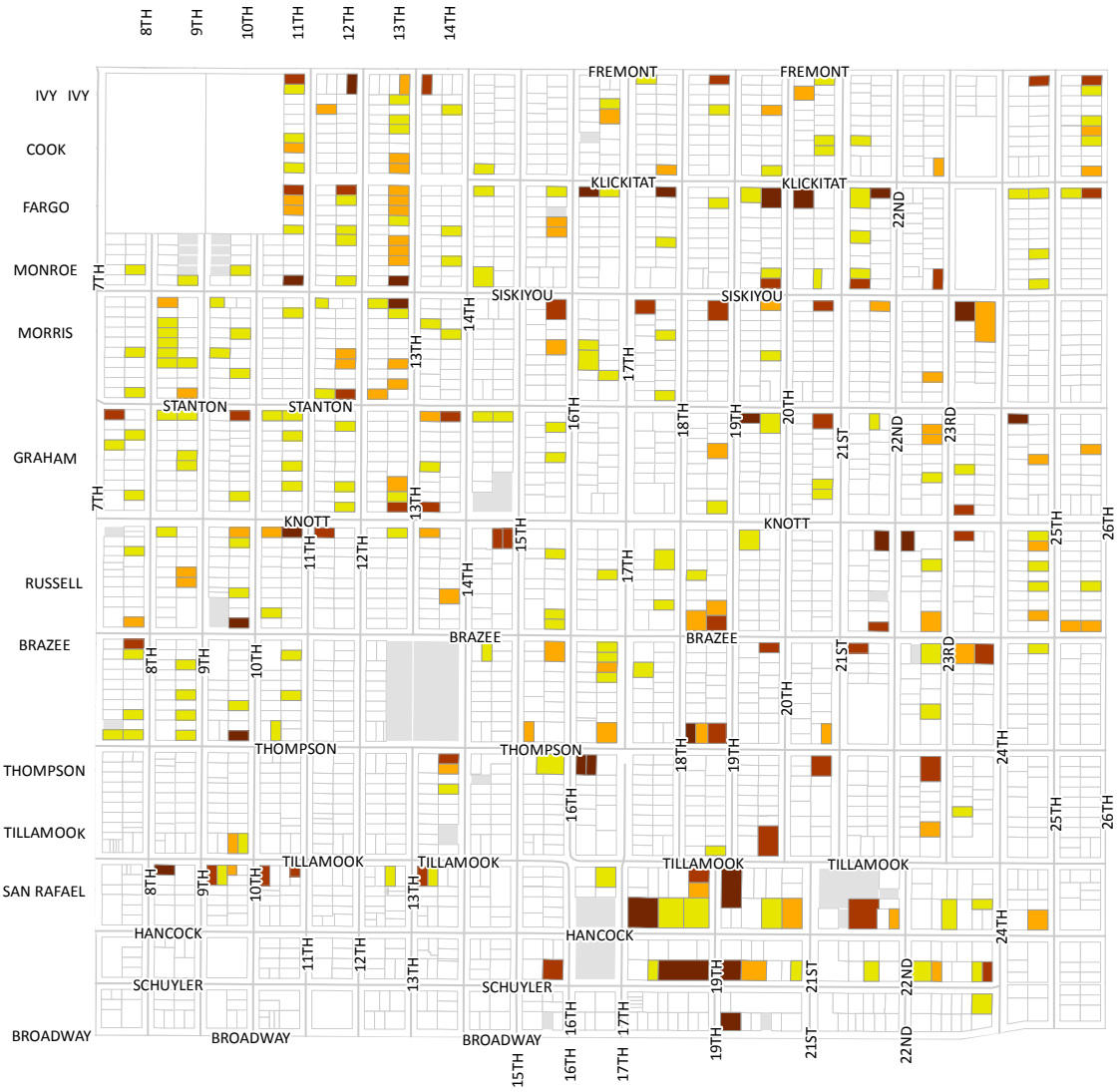
Available street tree planting sites



Appendix J: Priority street tree planting sites

Irvington Street Tree Inventory 2015

Priority street tree planting sites



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*Long chains of flowers on a Caucasian wingnut (*Pterocarya fraxinifolia*), Portland Heritage Tree #84.*

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