TREE MANAGEMENT PLAN

City of Hamtramck, Michigan

June 2019

Prepared for:
City of Hamtramck
City Hall
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ACKNOWLEDGMENTS

Hamtramck's vision to promote and preserve the urban forest and improve the management of public trees was a fundamental inspiration for this project. This vision will ensure canopy continuity, which will reduce stormwater runoff and improve aesthetic value, air quality, and public health.

Hamtramck is thankful for the funding it received from the Michigan Urban and Community Forestry Grant Program, through the Michigan Department of Natural Resources and the United States Forest Service. The U&CF Grant Program is designed to encourage communities to create and support long-term and sustained urban and community forestry programs throughout Michigan.

The city also recognizes the support of its Mayor and city council:

- Karen Majewski, Mayor
- Anam Miah, Mayor Pro-Tem
- Andrea Karpinski, Council Member
- Abu Musa, Council Member
- Saad Almasmari, Council Member
- Ian Perrotta, Council Member
- Fadel Al-Marsoumi, Council Member

EXECUTIVE SUMMARY

The City of Hamtramck's *Tree Management Plan* was developed by the Davey Resource Group, Inc. "DRG" to address short- and long-term maintenance needs of the city's inventoried public trees. DRG began the plan development process by completing an inventory of trees, stumps, and planting sites along the public street rights-of-way (ROW) and select parks and public facilities within the City of Hamtramck. Data from the tree inventory were analyzed to gain an understanding of the needs of the urban forest, develop tree maintenance recommendations, and quantify the environmental, economic, and social benefits that Hamtramck's public trees provide to the community. This analysis coupled with a review of the city's existing urban forestry program and an understanding of the community's urban forest vision were the basis for this plan.

State of the Existing Urban Forest

During the spring of 2019, DRG conducted an inventory of trees, stumps, and planting sites along public street rights-of-way (ROW), and in select parks and public facilities within the City of Hamtramck. The parks and facilities selected for the inventory were: Pope Park, Veterans Memorial Park, Zussman Park, and City Hall.

The inventory recorded a total of 3,282 sites which included: 1,911 trees, 116 stumps, and 1,255 planting sites. An analysis of the inventory was conducted and its findings, detailed below, provide a snapshot of the current state of Hamtramck's urban forest.

Diversity and Threats

- The inventory identified 75 species growing along streets, in parks, and on city facility properties in the City of Hamtramck.
- Of the 75 species identified, *Acer platanoides* (Norway maple) and *Pyrus calleryana* (Callery pear) make up the largest percentages of the inventoried population, 25% and 14%, respectively.
- At the genus level, *Acer* (maple) dominates the inventoried population, representing 43% of the total population.
- Urban forests that are dominated by only a few species/genera are vulnerable to attack by species-specific epidemics, which can lead to significant losses in a community's tree canopy. A recent example of this vulnerability is the impact that the emerald ash borer had on ash trees and urban tree canopy in southeast Michigan communities over the last 15+ years.
- Granulate ambrosia beetle (*Xylosandrus crassiusculus*), spotted lanternfly (*Lycorma delicatula*), and Asian longhorned beetle (ALB or *Anoplophora glabripennis*) pose the greatest threats to the health of the inventoried population.

Size and Age Distribution

- The city's inventoried tree population trends towards the ideal size and age class distribution with younger (smaller) trees making up a greater number of the population than establishing, maturing, or mature trees.

Condition and Location

- The overall condition of the inventoried tree population is rated **Good.**

- Notes commonly recorded about inventoried trees included those regarding restricted growing space, damage to the tree trunk and support structures, and improper pruning cuts.
- Less than 1% of the street tree population was interfering with overhead utilities.
- On average, each of Hamtramck's city-owned trees provides $101.45 in annual benefits.

Benefits

- The inventoried tree canopy provides a total of $193,872 in annual benefits including:
    - *Aesthetic and other benefits*: valued at $93,529 million per year.
    - *Energy*: Over 110 megawatt-hours (MWh) and 41,189 therms (thm) valued at $73,372 per year.
    - *Stormwater flow reductions:* Approximately 1.7 million gallons valued at $14,019 per year.
    - *Air quality*: 1,859 pounds of pollutants removed valued at $11,399 per year.
    - *Net total carbon sequestered and avoided*: 121 tons sequestered, 140 tons mitigated annually through avoidance, valued together at $1,553 per year.

Tree Maintenance and Planting Needs

To achieve a sustainable urban forest that maximizes the many environmental, economic, and social benefits that trees provide requires a city to focus on both reactive and proactive maintenance activities. Reactive activities include tree removals and high priority pruning, while proactive activities focus on routine pruning cycles and tree planting.

To assist the City of Hamtramck in identifying and prioritizing tree maintenance activities to maximize these benefits, the inventory provided a risk rating and recommended maintenance activity for each tree. The following recommended maintenance activities were identified with the percentage of inventoried trees in each maintenance category in parentheses: Tree Removal (3%); Stump Removal (4%); Routine Pruning (28%); Discretionary Pruning (7%); Young Tree Train (20%); and Plant Tree (38%).

Maintenance activities should be prioritized by risk, addressing those trees with the highest risk first. No trees inventoried were noted in the highest risk category "Extreme Risk"; however, there were several trees noted in the "High Risk" category (6 trees or 0.2% of the inventoried trees). Trees in the "High Risk" category should be removed or pruned immediately to mitigate risk and improve public safety. Trees in the "Moderate Risk" and "Low Risk" categories should be addressed after maintenance of the higher risk trees has been completed

TREE REMOVAL	• Total = 114 trees • Extreme Risk = 0 trees • High Risk = 4 trees • Moderate Risk = 44 trees • Low Risk = 66 trees
PRIORITY PRUNING	• Total = 57 trees • Extreme Risk Pruning = 0 trees • High Risk Pruning = 2 trees • Moderate Risk Pruning = 55 trees
ROUTINE PRUNING	• Total = 1,740 trees • Low Risk Pruning = 864 trees • Discretionary Pruning = 221 trees • Young Tree Training = 655 • Number of trees in cycle each year = approximately 352
STUMP REMOVAL	• Total = 116 stumps
TREE PLANTING	• Total = 1,255 vacant sites • Number of trees each year = at least 75

After the city has addressed the maintenance needs of the Extreme, High, and Moderate Risk trees identified in the inventory, DRG recommends that Hamtramck develop and implement a proactive pruning cycle. Proactive pruning efforts will improve the overall health, condition, and structure of the city's tree population and may even lead to lower future urban forestry program costs. Pruning cycles help identify and correct defects in trees before they worsen, which may avoid costly problems in the future. As part of this cycle, at least 352 trees should be pruned, or in the case of young trees trained each year.

The final piece of developing a sustainable and resilient urban forest is the development of an annual street tree planting program. Tree planting is necessary to maintain/increase tree canopy cover, and to replace trees that have been removed or lost to natural mortality (approximately 1–3% of the public tree population per year) or other threats (e.g., impacts from construction, invasive pests, or drought, flooding, ice, snow, storms, and wind). DRG recommends the City of Hamtramck establish an annual program that plants at least 75 trees per year. The program should plant a variety of species to offset annual tree loss, increase canopy, maximize benefits, and increase tree species diversity. Due to the high percentage of *Acer (*maple), the city should limit the number of maple species used during new tree planting for the foreseeable future.

City tree planting efforts should focus on replacing removed tree canopy and establishing new canopy in neighborhoods with low tree canopy and areas that promote economic growth, such as business districts, recreational areas, trails, and areas where there are gaps in the existing canopy.

Urban Forest Program Needs

The City of Hamtramck has many opportunities to improve its urban forest; however, increased funding will be needed. Sustainable and adequate funding to implement an effective and systematic urban forest management program is essential. This proposed program aims to provide short-term and long-term public benefits, ensures priority maintenance is performed expediently, and establishes a proactive maintenance cycle. Maintaining the tree inventory using TreeKeeper® 8 or similar software is crucial for making informed management decisions and projecting accurate maintenance budgets.

The estimated total cost for the first year of this five-year program is $108,897. In order to minimize risk and address immediate hazards, high priority tree removals and pruning are scheduled during Year 1 of the program, leading to a higher total cost for that year. After high-priority work has been completed, tree maintenance activities will focus primarily on proactive maintenance, which generally costs less. Budgets for later years of the program are thus projected to be lower, decreasing to approximately $91,211 by Year 5 of the program. Investing in this tree management program will promote public safety, improve tree care efficiency, and increase the economic and environmental benefits the community receives from its trees. Over the long term, supporting and funding proactive management of trees will reduce municipal tree care management costs and lead to a more sustainable and resilient urban forest.

FY 2020 **$108,897**

- 48 Extreme, High, or Moderate Risk removals
- 37 Extreme, High, or Moderate prunes
- 5 Low Risk removals
- 352 Low Risk, discretionary, or training routine prunes
- 0 Stump removals
- 75 Trees recommended for planting and follow-up care
- Administration, legal, public outreach, and professional training = $10,000
- Tree inspections and inventory updates = $3,000
- Infrastructure repair and storm response = $10,000

FY 2021 **$97,954**

- 21 Extreme, High, or Moderate prunes
- 61 Low Risk removals
- 352 Low Risk, discretionary, or training routine prunes
- 0 Stump removals
- 75 Trees recommended for planting and follow-up care
- Administration, legal, public outreach, and professional training = $10,000
- Tree inspections and inventory updates = $3,000
- Infrastructure repair and storm response = $10,000

FY 2022 **$93,856**

- 352 Low Risk, discretionary, or training routine prunes
- 58 Stump removals
- 75 Trees recommended for planting and follow-up care
- Administration, legal, public outreach, and professional training = $10,000
- Tree inspections and inventory updates = $3,000
- Infrastructure repair and storm response = $10,000

FY 2023 **$92,576**

- 352 Low Risk, discretionary, or training routine prunes
- 38 Stump removals
- 75 Trees recommended for planting and follow-up care
- Administration, legal, public outreach, and professional training = $10,000
- Tree inspections and inventory updates = $3,000
- Infrastructure repair and storm response = $10,000

FY2024 **$91,211**

- 352 Low Risk, discretionary, or training routine prunes
- 20 Stump removals
- 75 Trees recommended for planting and follow-up care
- Administration, legal, public outreach, and professional training = $10,000
- Tree inspections and inventory updates = $3,000
- Infrastructure repair and storm response = $10,000

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INTRODUCTION

The City of Hamtramck is a small, unique, and diverse community located in southeast Michigan. At just over 2 square miles, it is home to more than 22,000 residents who enjoy the beauty and benefits of their urban forest. The city is responsible for the management and maintenance of the public urban forest which includes trees, stumps, and planting sites located in select parks, public facilities, and along street rights-of-way (ROW). Funding for the Hamtramck's urban forestry program comes from the general fund.

Approach to Tree Management

DRG believes that the best approach to developing and managing a sustainable urban forest is to create an organized, proactive program by utilizing an up-to-date tree inventory and management plan to set goals and measure progress. This belief comes from decades of research and experience that has shown that by utilizing these tools a community can gain an understanding of its urban forest resource, establish tree care priorities, build strategic planting plans, draft cost-effective budgets based on projected needs, and minimize the need for costly, reactive solutions to crises or urgent hazards.

In the spring of 2019, the City of Hamtramck, recognizing the value of their urban forest and the need to develop a sustainable urban forest, contracted with DRG to conduct an inventory of public trees and develop a tree management plan. The following tasks were completed as part of the project:

- Inventory of trees, stumps, and planting sites along the street ROW and within specified parks and facilities.
- Analysis of tree inventory data.
- Development of a plan that prioritizes recommended tree maintenance.

The *Tree Management Plan* provides an analysis of the diversity, distribution, and general condition of the inventoried trees, and provides a prioritized system for managing them. The plan is divided into three sections:

- *Section 1: Tree Inventory Analysis* summarizes the tree inventory data and presents trends, results, and observations.
- *Section 2: Benefits of the Urban Forest* summarizes the economic, environmental, and social benefits that trees provide to the community. This section presents statistics based on an i-Tree Streets benefits analysis conducted for the City of Hamtramck.
- *Section 3: Tree Management Program* utilizes the inventory data to develop a prioritized maintenance schedule and projected budget for the recommended tree maintenance over a five-year period.

SECTION 1: TREE INVENTORY ANALYSIS

In the spring of 2019, DRG arborists, certified by the International Society of Arboriculture, assessed and inventoried trees, stumps, and planting sites along the street ROW, selected parks, and public facilities. The parks and facilities selected for the inventory were: Pope Park, Veterans Memorial Park, Zussman Park, and City Hall.

A total of 3,282 sites were collected during the inventory: 1,911 trees, 116 stumps, and 1,255 planting sites. Of the sites collected, 95.3% were collected along the street ROW, and the remaining 4.7% were collected in parks and city facilities. Figure 1 provides a detailed breakdown of the number and type of sites inventoried.

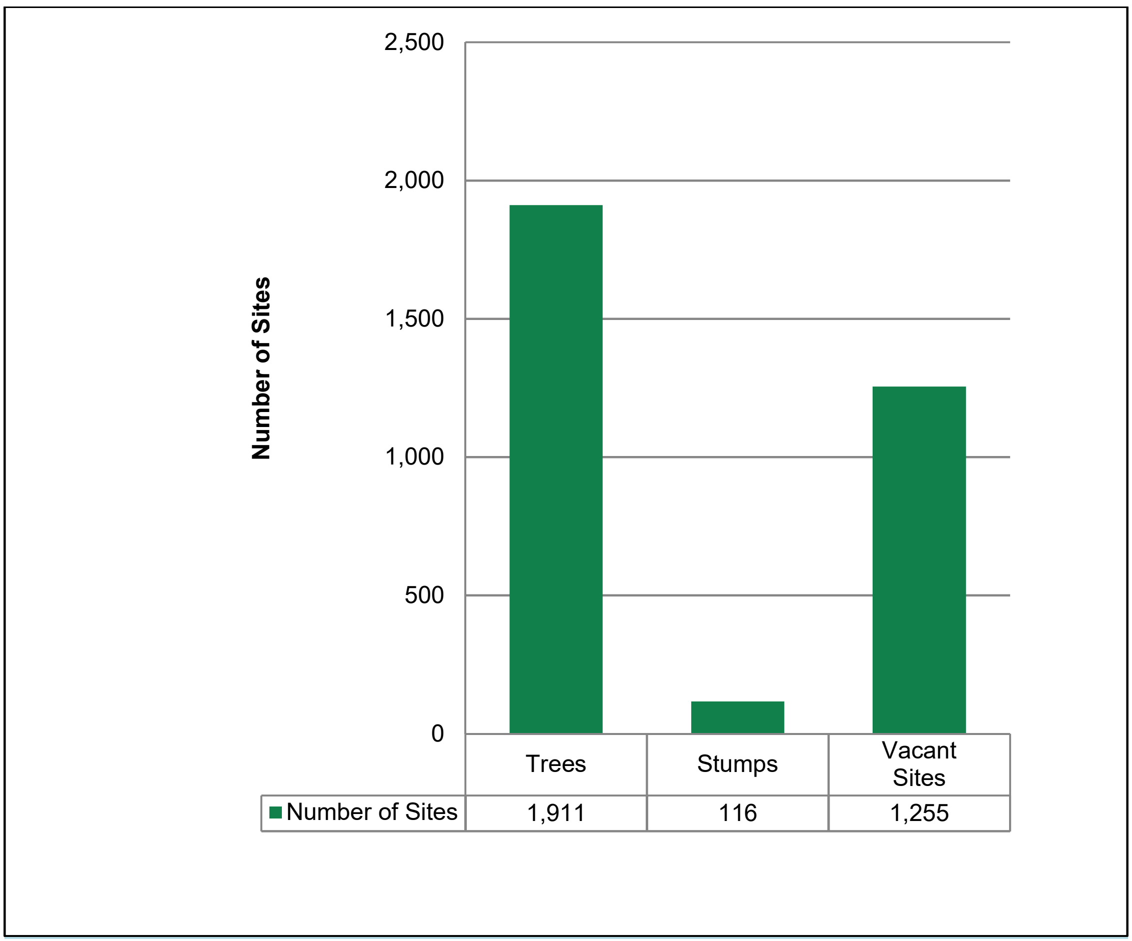


Figure 1. Sites collected during the 2019 inventory.

Assessment of Tree Inventory Data

Data analysis and professional judgment are used to draw conclusions about the state of the inventoried tree population. Recognizing trends in the data can help guide short-term and long-term management planning. For this plan, the following criteria and indicators were used to assess the inventoried tree population:

Photograph 1. *Davey's ISA Certified Arborists inventoried trees along street ROWs and in select community parks to collect information about trees that could be used to assess the state of the urban forest.*

- *Species Diversity* is the variety of species in a specific population and affects the population's ability to withstand threats from invasive pests and diseases. Species diversity also impacts tree maintenance needs and costs, tree planting goals, and canopy continuity.
- *Diameter Size Class Distribution* Data are used to determine the statistical distribution of the trunk diameter size classes of a given tree population and are used to indicate the relative age of a tree population. The number of trees in each diameter size class (distribution) affects the valuation of tree-related benefits as well as the projection of maintenance needs and costs, planting goals, and canopy continuity.
- *Condition* assesses the general health of a tree population and indicates how well trees are performing given their site-specific conditions. General health affects both short-term and long-term maintenance needs and costs as well as canopy continuity.
- *Stocking Level* is the proportion of existing street trees compared to the total number of potential street trees (number of inventoried trees plus the number of potential planting spaces). Stocking level can help determine tree planting needs and budgets.
- *Other Observations* provides insight into past maintenance practices and growing conditions that may affect future management decisions.
- *Further Inspection* indicates whether a particular tree requires additional inspection, such as a Level III risk inspection in accordance with ANSI A300, Part 9 (ANSI 2011), or periodic inspection due to particular conditions that may cause the tree to be a safety risk and, therefore, hazardous.

Appendix A provides specific information on data collection and site location methods.

Species Diversity

Species diversity affects maintenance costs, planting goals, canopy continuity, and the forestry program's ability to respond to threats from invasive pests or diseases. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics, such as the devastating results Dutch elm disease (*Ophiostoma novo-ulmi*) had on *Ulmus americana* (American elm trees) throughout the Midwest. American elms were a popular and over-planted street tree in Midwestern cities and towns during the early 20th century. They were so overused that some streets were planted exclusively with them. The discovery and rapid spread of Dutch elm disease beginning in the 1930s, combined with the disease's continued prevalence today, has led to the death of a massive number of American elms. The impacts of losing so many American elms stripped many midwestern cities of their canopy cover.

Following the loss of American elm, many replanting efforts focused on using a combination of *Acer* (maple) and *Fraxinus* (ash), leading to an overabundance of these trees in many communities. Communities in Michigan were further impacted by a lack of diversity when the emerald ash borer killed the ash trees planted to replace American elms. Today, Asian longhorned beetle (ALB, *Anoplophora glabripennis*) and oak wilt (caused by the fungus *Bretziella fagacearum*), a non-native insect and disease, respectively, are attacking and killing some of the most prevalent shade trees throughout the country.

To ensure there is adequate species diversity in a community, the composition of a tree population should follow the 10-20-30 Rule for species diversity: a single species should represent no more than 10% of the urban forest, a single genus no more than 20%, and a single family no more than 30%.

Example: 10-20-30 Rule

Species (10%): *Acer saccharum* (sugar maple)

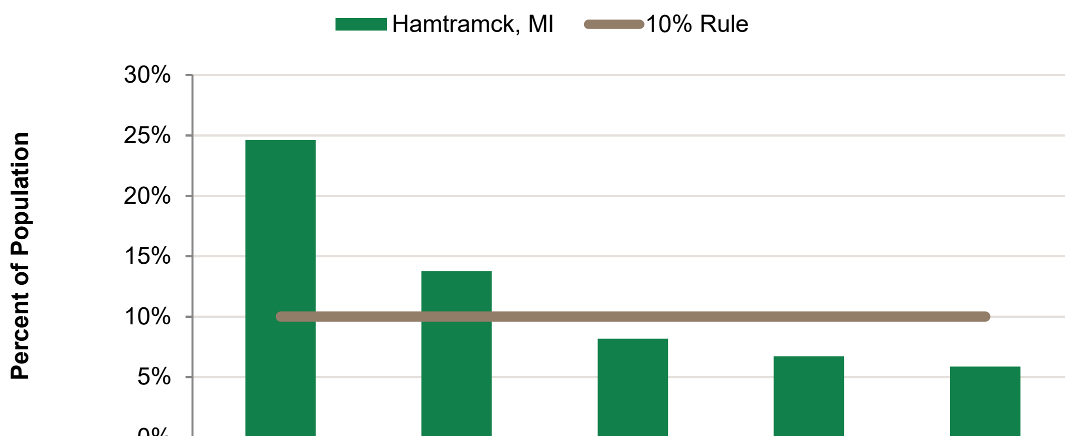
Genus (20%): *Acer* (maple)

Family (30%): *Sapindaceae (*soapberry family that includes the genus maple and species sugar maple)

Findings

An analysis of the City of Hamtramck's tree inventory data indicates that the city's inventoried tree population is comprised of 44 genera and 75 species.

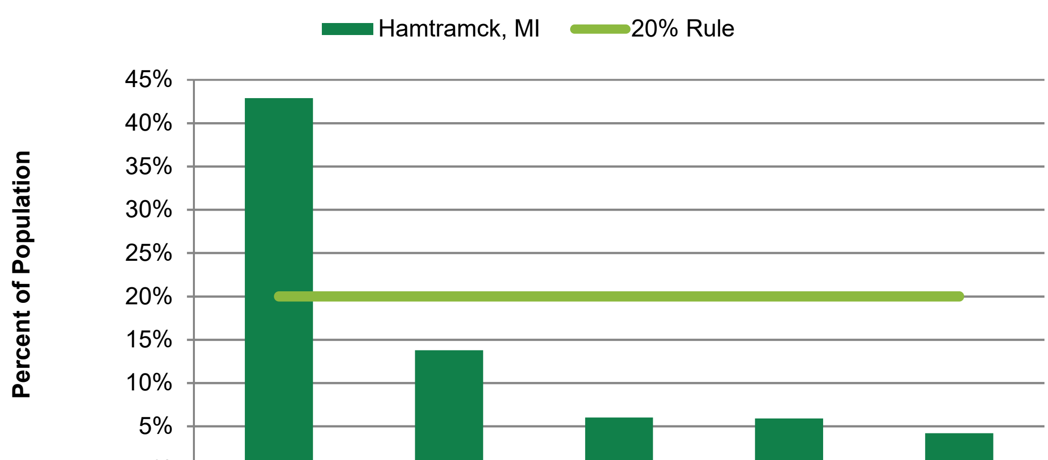
Figure 2 uses the 10% Rule to compare the percentages of the most common species identified during the inventory. *Acer platanoides* (Norway maple) and *Pyrus calleryana* (Callery pear) comprising 25% and 14% of the inventoried tree population, respectively, both exceed the recommended 10% maximum for a single species in a population. *Acer rubrum* (red maple) and *A. saccharinum* (silver maple) are approaching the 10% threshold.



	Norway maple	Callery pear	red maple	silver maple	thornless honeylocust
Hamtramck, MI	25%	14%	8%	7%	6%
10% Rule	10%	10%	10%	10%	10%

Figure 2. Five most abundant species of the inventoried population compared to the 10% Rule.

In Figure 3, the 20% Rule is used to compare the percentages of the most common genera identified during the inventory. *Acer* (maple) far exceed the recommended 20% maximum for a single genus in a population, comprising 43% of the inventoried tree population. *Pyrus* (pear) at 14%, which in the inventoried population consisted entirely of Callery pear, approaches the 20% threshold.



	maple	pear	apple	honeylocust	oak
Hamtramck, MI	43%	14%	6%	6%	4%
20% Rule	20%	20%	20%	20%	20%

Figure 3. Five most abundant genera of the inventoried population compared to the 20% Rule.

Discussion/Recommendations

Acer (maple) dominate the city's streets and parks and is putting the city's urban tree canopy at risk. The impacts of having an overabundance of a particular genus/species as described previously make the goal of improving tree diversity in the city an important one of the City of Hamtramck to pursue.

Considering the large quantity of *Acer* (maple) in the city's population, along with its susceptibility to Asian longhorned beetle (ALB, *Anoplophora glabripennis*) and granulate ambrosia beetle (*Xylosandrus crassiusculus*), the planting of *Acer* (maple) should be limited to minimize the potential for loss in the event that these pests threaten Hamtramck's urban tree population. Focusing on increasing the diversity of the city's tree population will ensure Hamtramck's urban forest is sustainable and resilient to future invasive pest infestations. Appendix C provides a recommended list of tree species to be used in planting.

Diameter Size Class Distribution

Analyzing the diameter size class distribution of the city's inventoried trees provides an estimate of the relative age of the tree population and offers insight into maintenance practices and needs.

The inventoried trees were categorized into the following diameter size classes listed as DBH or diameter at breast height:

- Young (0–8 inches DBH)
- Established (9–17 inches DBH)
- Maturing (18–24 inches DBH)
- Mature (greater than 24 inches DBH)

These categories were chosen so that the population could be analyzed according to Richards' ideal distribution (1983). Richards proposed an ideal diameter size class distribution for street trees based on observations of well-adapted trees in Syracuse, New York. Richards' ideal distribution suggests that the largest fraction of trees (approximately 40% of the population) should be young (less than 8 inches DBH), while a smaller fraction (approximately 10%) should be in the large-diameter size class (greater than 24 inches DBH). A tree population with an ideal distribution would have an abundance of newly planted and young trees, and lower numbers of established, maturing, and mature trees.

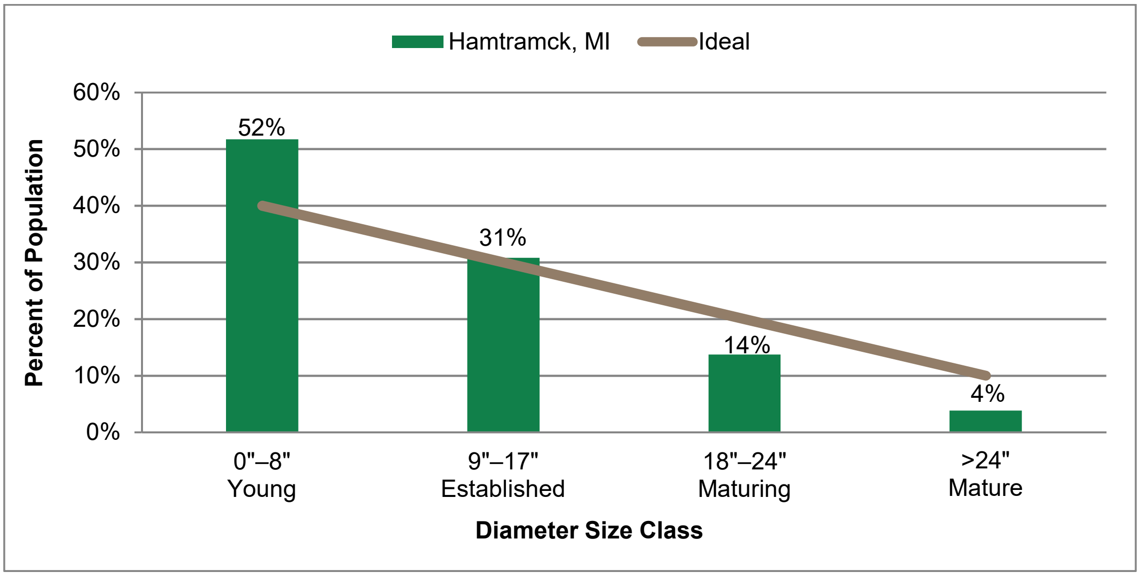


Figure 4. Comparison of diameter size class distribution for inventoried trees to the ideal distribution.

Findings

Figure 4 compares Hamtramck's diameter size class distribution of the inventoried tree population to the ideal proposed by Richards (1983). Hamtramck's distribution trends towards the ideal; young trees exceed the ideal by over 12%, while larger diameter size classes fall below the ideal.

Discussion/Recommendations

One of the city's program objectives should be to have an uneven-aged distribution of trees at the street, park, and citywide levels, and while it may appear that Hamtramck has too many young trees, this is not necessarily the case. The skewed distribution is due in part to a lower than ideal percentage of established and maturing trees. To achieve the ideal tree distribution and allow the population distribution to normalize over time, DRG recommends that Hamtramck (1) promote tree preservation and proactive tree care to ensure the long-term survival of established, maturing and mature trees; and (2) support a strong planting and maintenance program to ensure that young, healthy trees are in place to fill tree canopy gaps and replace older declining trees.

For more information on maintenance and planting recommendations, see Appendix B for risk assessment and priority maintenance; Appendix C for a recommended tree species planting list; and Appendix D for planting and species selection information.

Planting trees is necessary to increase canopy cover and replace trees lost to natural mortality (expected to be 1%–3% per year) and other threats (for example, invasive pests or impacts from weather events such as storms, wind, ice, snow, flooding, and drought). Planning for the replacement of existing trees and identifying the best places to create new canopy is critical.

Condition

DRG assessed the condition of individual trees based on methods defined by the International Society of Arboriculture (ISA). The condition assessment considered several factors for each tree, including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests. Following the condition assessment, each inventoried tree was given a condition rating of Good, Fair, Poor, or Dead.

In this plan, the general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory.

Comparing the condition of the inventoried tree population with relative tree age (or size class distribution) can provide insight into the stability of the population. Since tree species have different lifespans and mature at different sizes (i.e., diameters, heights, and crown spreads), actual tree age cannot be determined from diameter size class alone. However, general classifications of size can be extrapolated into relative age classes. The following categories are used to describe the relative age of a tree:

- Young (0–8 inches DBH)
- Established (9–17 inches DBH)
- Maturing (18–24 inches DBH)
- Mature (greater than 24 inches DBH)

Figures 5 and 6 illustrate the general health and distribution of young, established, mature, and maturing trees relative to their condition.

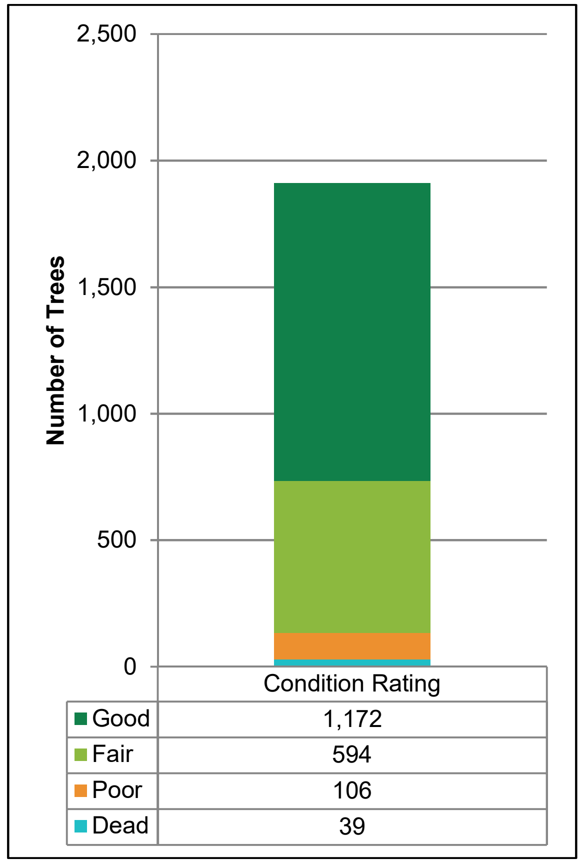


Figure 5. Conditions of inventoried trees.

Findings

The majority of the inventoried trees, 61%, were recorded to be in Good condition (Figure 5), and based on this, the general health of the overall inventoried tree population is rated as Good. As shown in Figure 6, most of the young and established trees were rated to be in Good condition, and most of the maturing and mature trees were rated to be in Fair condition.

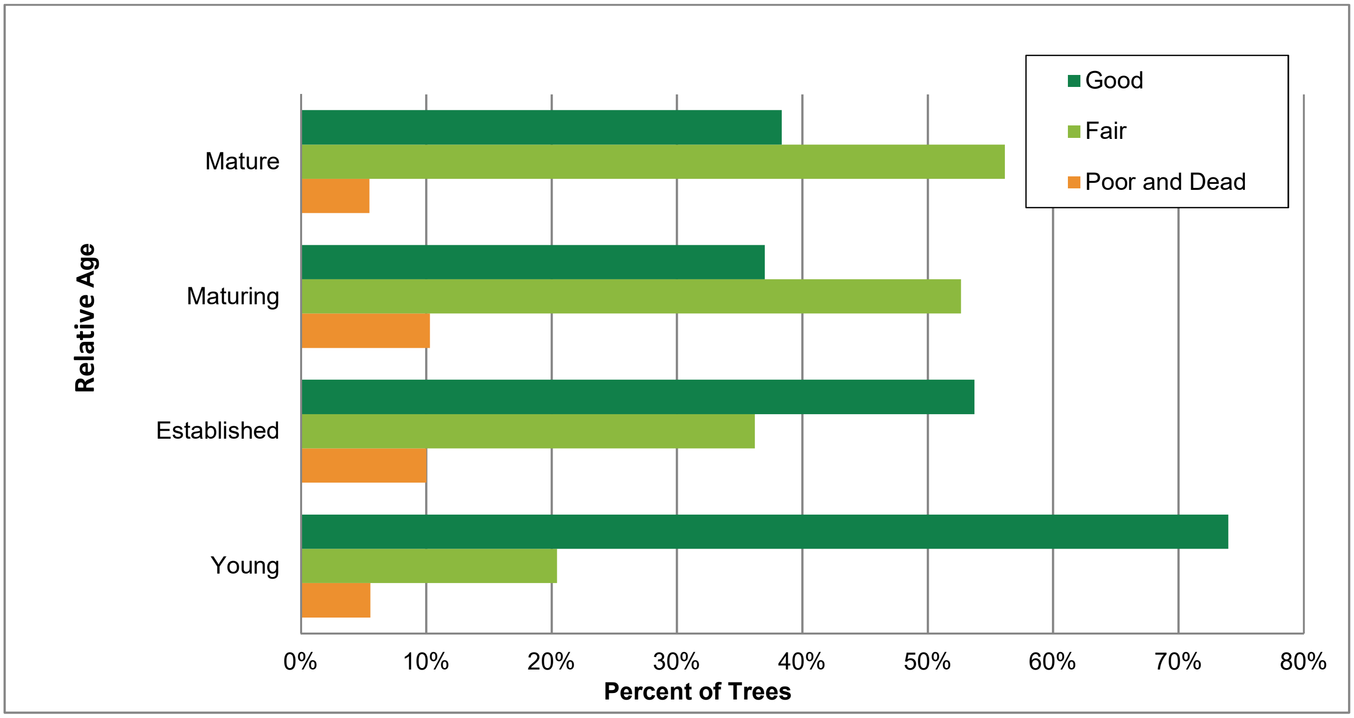


Figure 6. Tree condition by relative age during the 2019 inventory.

Discussion/Recommendations

While the overall condition of Hamtramck's inventoried tree population is Good, data analysis, observations, and historical maintenance practices have provided the following insights and recommendations into maintenance needs:

- Dead and dying trees should be removed because of their failed health; these trees will likely not recover, even with increased care.
- Younger trees rated in Fair or Poor condition may benefit from improvements in structure that may improve their health over time. Pruning should follow *ANSI A300 (Part 1)* (ANSI 2017).
- Poor condition ratings among maturing and mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, or poor structure. These trees will require corrective pruning, regular inspections, and possible intensive plant health care to improve their vigor.
- Restrictive growth space size likely contributed to the poor condition rating of some trees, especially those in the maturing and mature tree size classes.
- Proper tree care practices are needed for the long-term general health of the urban forest. Many of the newly planted trees had signs of mechanical damage (injuries caused by string trimmer or mowers) or staking hardware attached to them long after they should have been removed. Following guidelines developed by ISA and those recommended by *ANSI A300 (Part 6)* (ANSI 2012) will ensure that tree maintenance practices ultimately improve the health of the urban forest.

Street ROW Stocking Level and Trees Per Capita

Stocking is a traditional forestry term used to measure the density and distribution of trees. For an urban forest such as Hamtramck's, stocking level is used to estimate the total number of sites along the street ROW that could contain trees. Park trees and public property trees are excluded from this measurement.

Stocking level is determined by looking at the ratio of street ROW spaces occupied by trees to the total street ROW spaces suitable for trees. For example, based on an inventory of ROW street trees that contains a total of 1,000 sites, which includes 750 existing trees and 250 planting sites, the street ROW stocking level is 75%.

For an urban area, DRG recommends that the street ROW stocking level be at least 90%, where no more than 10% of the potential planting sites along the street ROW are vacant.

Calculating trees per capita is another method to determine the density of a city's urban forest. The more residents and greater housing density a city possesses, the greater the need for trees and the benefits they provide.

Findings

Comparing the total number of trees, 1,765 in the city's ROW, to the total number of sites (i.e., trees, stumps, and planting sites), 3,129 along the city's ROW, Hamtramck's current ROW street tree stocking level is 56%.

The following is a break-down of the 1,255 planting sites inventoried based on the growing space size and whether the site is suitable for a large, medium, or small mature tree:

- 26 were potential planting sites for large-size trees (growing space of 8 feet wide or greater).
- 354 were potential sites for medium-size trees (growing space of 6 to 7 feet wide).
- 875 were potential sites for small-size trees (growing space of 4 to 5 feet wide).

The City of Hamtramck's ratio of street trees per capita, based on census data, is approximately 0.08, which falls well below the mean ratio of 0.37 reported for 22 U.S. cities (McPherson and Rowntree 1989).

Discussion/Recommendation

Fully stocking the street ROW with trees and increasing the ratio of street trees per capita are excellent goals for the City of Hamtramck to pursue. Working to attain a fully stocked street ROW is important to promote canopy continuity and urban forest resilience and sustainability. The city can improve its street ROW population's stocking level of 56% and work towards achieving the ideal of 90% or better by developing a planned program of planting, care, and maintenance for the city's street trees.

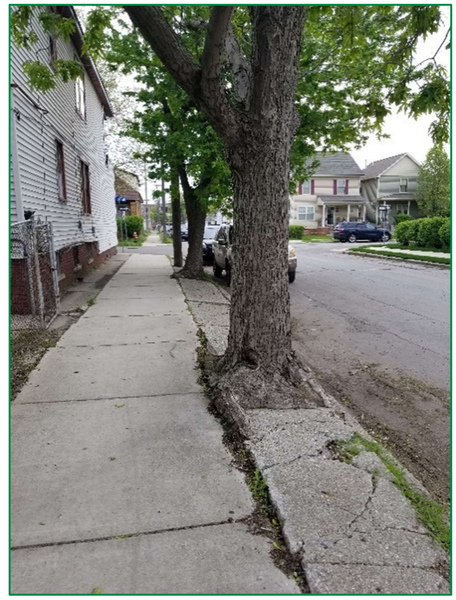
The City of Hamtramck estimates that it plants 25–50 trees per year. With a total of 1,255 planting sites along the street ROW, it will take approximately 21 years for the city to reach the recommended stocking level of 90%. If budgets allow, DRG recommends that Hamtramck increase the number of trees planted to at least 75. If possible, the city should strive to exceed this recommendation to better prepare for impending threats and to increase the benefits provided by the urban forest.

Other Observations and Comments

Although no categorical observations were collected, general comments were recorded during the inventory to further describe a tree's health, structure, or location when more detail was needed.

Findings

The most common recorded comment of the inventoried population was 'expand pit' which was used to indicate that the tree had outgrown its growth area. Other common notes included 'improper pruning', 'root damage', and 'mechanical damage'.



Photograph 2. *The silver maple has extremely limited growth space. Where possible, pits like this should be expanded. For future planting efforts, it is important to emphasize the right tree in the right place.*

Discussion/Recommendations

Unless slated for removal, trees with comments indicating issues with restricted growth space, roots, or damage to below ground structures should be considered for monitoring and potential growth space expansion. Cutting, rerouting, or otherwise changing the sidewalk and infrastructure around these trees is likely the best method to help improve the condition of these trees.

Trees exist with equivalent percentages of biomass above and below ground, although this mass is not distributed the same way. The root system of trees exists primarily close to the soil surface and when uninhibited extends well past the tree canopy. In an urban setting, sprawling root systems are often not possible outside of parks. When it comes to ROW trees, it is important to give trees adequate space, with a goal of extending this space at least to the critical root zone (CRZ) or the edge of the canopy drip line.

Future planting efforts should consider growth space size as it relates to tree selection. The inventoried vacant sites were broken down into three size classes based on the width of available tree lawn. Evaluating site conditions to ensure that the right tree species is being planted in the right place is critical to mitigating future hazards and ensuring the tree's future success as it establishes.

Trees noted as being improperly pruned or having improper pruning cuts will likely need to be re-pruned or monitored. In some cases, these poor pruning cuts were the result of homeowner activity. Enacting a routine pruning cycle can help mitigate the amount of tree work performed by homeowners or concerned citizens and ensure that pruning is done properly. Any pruning work that the city or contractors perform should be done to *ANSI A300 (Part 1)* (ANSI 2017) pruning standards.

Trees noted as having mechanical or root damage should be considered candidates for mulching or other trunk protection efforts.

Infrastructure Conflicts

In an urban setting, space is limited both above and below ground. This presents challenges for trees growing in these settings as they can conflict with infrastructure such as buildings, sidewalks (hardscape), utility wires, and pipes, which may pose risks to public health and safety. The presence of overhead primary and secondary electric lines above a tree or planting site were collected during the inventory. It is important to consider this data when planning pruning activities and selecting tree species for planting.

Findings

There were 15 trees with primary or secondary electric utilities passing through or otherwise within close range of the tree canopy. Additionally, there were 179 sites where these utilities were present, although they did not conflict directly with a tree at the time of observation.

Table 1. Trees Noted to be Conflicting with Infrastructure

Conflict	Presence	Number of Trees	Percent
Overhead Utilities	Present and Conflicting	15	0.46
	Present and Not Conflicting	179	5.45
	Not Present	3,088	94.09
Total		**3,282**	**100**

Discussion/Recommendations

Tree canopy should not interfere with vehicular or pedestrian traffic, nor should it rest on buildings or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should be completed in accordance with *ANSI A300 (Part 9)* (2017). Although clearance levels were not collected directly during the inventory, this information was captured in the primary maintenance field with these trees falling under a 'Prune' recommendation. DRG's clearance distance guidelines are as follows: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.

Trees currently conflicting with overhead utilities can be difficult to manage. Prior to any work around utility lines, ensure that staff and contractors have adequate and up-to-date training and certification for utility line clearance. Proper pruning cuts should be made to allow trees and utilities to coexist where possible. Where this is not possible, tree removal should be considered.

To help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines. Plant only small-growing trees within 20 feet of overhead utilities, medium-size trees within 20–40 feet, and large-growing trees outside 40 feet.

When planting around hardscape, it is important to give the tree enough growing room above ground. Space guidelines for planting trees among hardscape features are as follows: give small-growing trees 4–5 feet, medium-growing trees 6–7 feet, and large-growing trees 8 feet or more between hardscape features. In most cases, this will allow for the spread of a tree's trunk taper, root collar, and immediate larger-diameter structural roots.

Hardscape conflicts present in the inventory should be managed primarily by removing the offending hardscape. Root pruning can be difficult and cause permanent damage to trees. As with overhead utilities, if the level interference with hardscape is too high, tree removal should be considered.

Growing Space

Information about the type and size of the growing space where trees and sites were located was recorded in the inventory. Growing space size was recorded as the minimum width of the growing space needed for root development; and growing space types were categorized as follows:

- Island—surrounded by pavement or hardscape (for example, parking lot divider).
- Median—located between opposing lanes of traffic.
- Open/Restricted—open sites with restricted growing space on two or three sides.
- Open/Unrestricted—open sites with unrestricted growing space on at least three sides.
- Tree Lawn/Parkway—located between the street curb and the public sidewalk.
- Natural Area—located in areas that do not appear to be regularly maintained.
- Well/Pit—at grade level and completely surrounded by sidewalk.
- Other—a site type that otherwise does not meet the above criteria.

Findings

The vast majority, 88%, of the inventoried sites were located in tree lawns; 7% were located in tree wells or pits, and 5%, mostly in parks, were located in open/unrestricted areas.

Discussion/Recommendations

To prolong the useful life of street trees, small-growing tree species should be planted in tree lawns 4–5 feet wide, medium-size tree species in tree lawns 6–7 feet wide, and large-growing tree species in tree lawns at least 8 feet wide. The useful life of a public tree ends when the cost of maintenance exceeds the value contributed by the tree. This can be due to increased maintenance required by a tree in decline, or by the costs of repairing damage caused by the tree's presence in a restricted site.

On streets where tree lawn growth space is limited, outreach efforts focused on encouraging residents to plant and maintain trees in their yards can provide great community benefits while engaging the community in the planting and care of the urban forest.

Potential Threats from Pests

Insects and diseases pose serious threats to the health of a community's trees and urban forest. Understanding and awareness of potential pests, along with early detection, is essential to ensuring the health and continuity of street and park trees.

Many pests target a single species or an entire genus. The inventory data was analyzed to provide a general estimate of the percentage of trees susceptible to some known tree pests (see Figure 7). It is important to note that the figure only presents data collected from the inventory. Many more trees throughout Hamtramck, including those on public and private property, may be susceptible to these invasive pests. Appendix E provides information about some of the current potential threats to Hamtramck's trees and includes websites where more detailed information can be found.

Findings

Granulate ambrosia beetle (*Xylosandrus crassiusculus*), spotted lanternfly (*Lycorma delicatula*), and Asian longhorned beetle (ALB or *Anoplophora glabripennis*) are known threats to a large percentage of the inventoried street trees (65%, 57%, and 46%, respectively). These pests were not detected in Hamtramck, but if found, the city could see severe losses in its tree population.

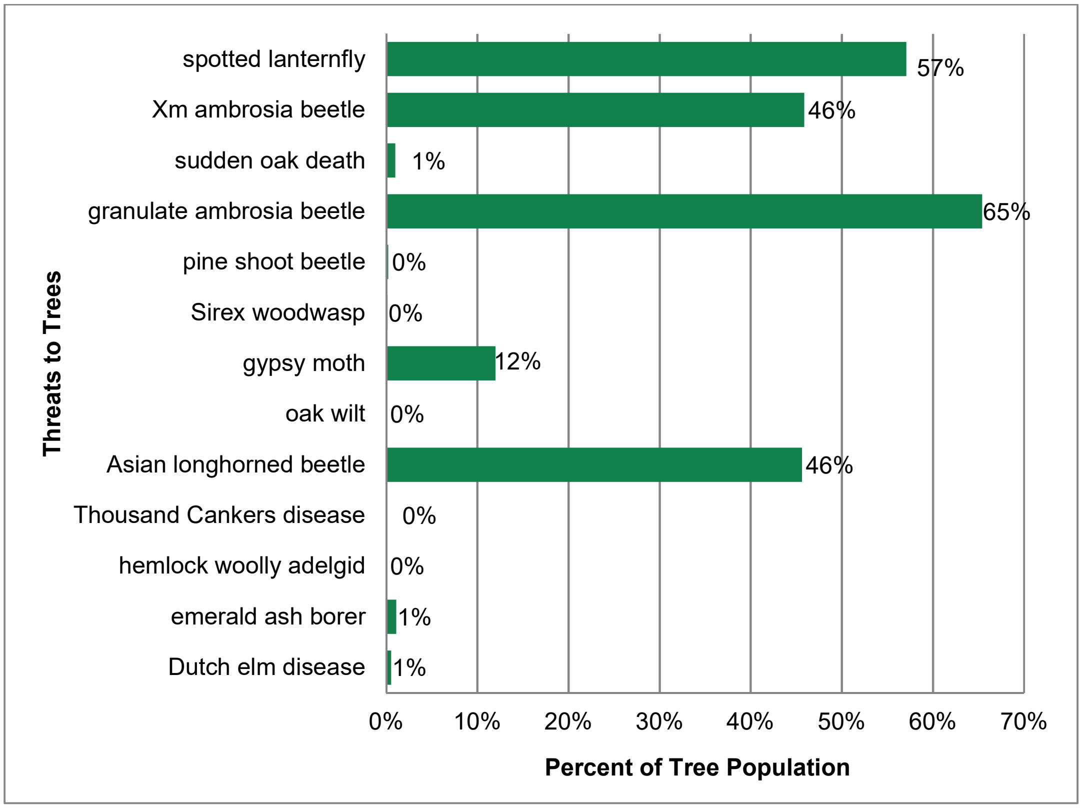


Figure 7. Potential impact of insect and disease threats noted during the 2019 inventory.

Discussion/Recommendations

Hamtramck should be aware of the signs and symptoms of potential infestations and be prepared to act if a significant threat is observed in its tree population or that of a nearby community. An integrated pest management plan should be established that focuses on identifying and monitoring threats, understanding the economic threshold, selecting the correct treatment, properly timing management strategies, recordkeeping, and evaluating results.

SECTION 2: BENEFITS OF THE URBAN FOREST

The urban forest plays an important role in supporting and improving the quality of life in urban areas. A tree's shade and beauty contribute to a community's quality of life, softening the often stark appearance of urban landscapes and streetscapes; and providing numerous tangible and intangible benefits such as pollution control, energy reduction, stormwater management, property value increases, wildlife habitat, education, and aesthetics. When properly maintained, the benefits trees provide far exceed the time and money invested in their planting, pruning, protection, and removal.

Environmental Benefits

- Trees decrease energy consumption and moderate local climates by providing shade and acting as windbreaks.
- Trees act as mini reservoirs, helping to slow and reduce the amount of stormwater runoff that reaches storm drains, rivers, and lakes. One hundred mature tree crowns intercept roughly 100,000 gallons of rainfall per year (U.S. Forest Service 2003a).
- Trees help reduce noise levels, cleanse atmospheric pollutants, produce oxygen, and absorb carbon dioxide.
- Trees can reduce street-level air pollution by up to 60% (Coder 1996). Lovasi (2008) suggested that children who live on tree-lined streets have lower rates of asthma.
- Trees stabilize soil and provide a habitat for wildlife.

Economic Benefits

- Trees in a yard or neighborhood increase residential property values by an average of 7%.
- Commercial property rental rates are 7% higher when trees are on the property (Wolf 2007).
- Trees moderate temperatures in the summer and winter, saving on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).
- On average, consumers will pay about 11% more for goods in landscaped areas, with this figure being as high as 50% for convenience goods (Wolf 1998b, Wolf 1999, and Wolf 2003).
- Consumers also feel that the quality of products is better in business districts surrounded by trees than those considered barren (Wolf 1998b).
- The quality of landscaping along the routes leading to business districts had a positive influence on consumers' perceptions of the area (Wolf 2000).

Social Benefits

- Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001a).
- Chicago apartment buildings with medium amounts of greenery had 42% fewer crimes than those without any trees (Kuo and Sullivan 2001b).
- Chicago apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees (Kuo and Sullivan 2001a).
- Employees who see trees from their desks experience 23% less sick time and report greater job satisfaction than those who do not (Wolf 1998a).
- Hospital patients recovering from surgery who had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall (Ulrich 1984, 1986).
- When surrounded by trees, physical signs of personal stress, such as muscle tension and pulse rate, were measurably reduced within three to four minutes (Ulrich 1991).

The services and benefits of trees in the urban and suburban setting were once considered to be unquantifiable. However, by using extensive scientific studies and practical research, these benefits can now be confidently calculated using tree inventory information. i-Tree Streets, a software tool developed to quantify the benefit of street trees, was utilized to analyze Hamtramck's tree inventory to determine the benefits of the city's inventoried trees. The results of Hamtramck's tree inventory coupled with the tree benefit analysis provide insight into the overall health of the city's public trees and the management activities needed to maintain and increase the benefits of trees into the future.

Photograph 3. *Trees provide significant aesthetic value to the community. Additionally, the tangible services of trees provide quantifiable benefits that justify the time and money invested in planting and maintenance.*

Tree Benefit Analysis

i-Tree Streets

In order to identify the dollar value provided and returned to the community, the City of Hamtramck's street tree inventory data were formatted for use in the i-Tree Streets benefit-cost assessment tool.

i-Tree Streets, a component of the USDA Forest Service's i-Tree software tools, analyzes a city's inventoried tree population to estimate its costs and benefits. The assessment tool creates an annual benefit report that demonstrates the value street trees provide to the community:

The reports and tree benefits provided through the i-Tree Streets analysis are described below.

- **Aesthetic/Other Benefits:** Shows the tangible and intangible benefits of trees reflected by increases in property values (in dollars).
- **Stormwater:** Presents reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons.
- **Carbon Stored:** Tallies all of the carbon dioxide (CO_2) stored in the urban forest over the life of its trees as a result of sequestration. Carbon stored is measured in pounds and has been translated to tons for this report.
- **Energy:** Presents the contribution of the urban forest towards conserving energy in terms of reduced natural gas use in the winter (measured in therms [thm]) and reduced electricity use for air conditioning in the summer (measured in Megawatt-hours ([MWh]).
- **Carbon Sequestered:** Presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reductions in energy use. This is measured pounds and has been translated to tons for this report. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

- **Air Quality:** Quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces, and reduced emissions from power plants (NO_2, PM_{10}, volatile organic compounds [VOCs], SO_2) due to reduced electricity use in pounds. The potential negative effects of trees on air quality due to biogenic volatile organic compounds (BVOC) emissions is also reported.

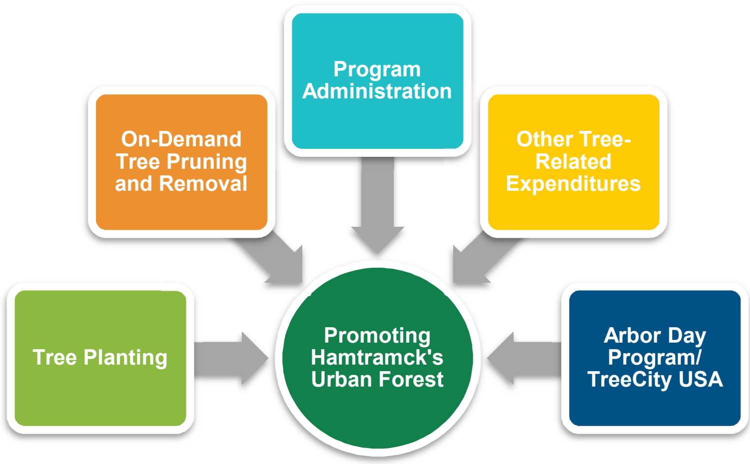
i-Tree Tools

i-Tree

i-Tree Tools software was developed by the U.S. Department of Agriculture, Forest Service (USDA FS) with the help of several industry partners, including The Davey Tree Expert Company. Learn more at www.itreetools.org.

THE BENEFITS OF HAMTRAMCK'S URBAN FOREST

i-Tree Streets Inputs



In addition to tree inventory data, i-Tree Streets requires cost-specific information to manage a community's tree management program—including administrative costs and costs for tree pruning, removal, and planting. Regional data, including energy prices, property values, and stormwater costs, are required inputs to generate the environmental and economic benefits trees provide. If community program costs or local economic data are not available, i-Tree Streets uses default economic inputs from a reference city selected by the USDA Forest Service for the climate zone in which your community is located. Any default value can be adjusted for local conditions.

Hamtramck's Inputs

Since specific local economic data for Hamtramck's urban forestry program were not available at the time of this plan, economic data from New York, NY were used to help calculate the inputs of Hamtramck's community, as the two cities are in the same climate zone.

Because unadjusted program economic defaults were used, the reporting function of the i-Tree Streets model is based on estimates of tree benefits. Net Annual Benefits, Cost for Public Trees, and Benefit-Cost Ratio (BCR) will not be calculated.

Annual Benefits

The i-Tree Streets model estimated that the inventoried street trees provide a total annual benefit of $193,872. Essentially, due to the presence of Hamtramck's public trees, $193,872 was saved to cool buildings, manage stormwater, clean the air, increase property values, and improve community aesthetics. On average, a single Hamtramck tree provides an annual benefit of $101.45.

The assessment found that aesthetics and other tangible and intangible benefits trees provide were the greatest value to the community, with approximately half of the total annual benefits due to increases in property value ($93,529). In addition to increasing property values, trees also play a major role in energy conservation. The city's trees provide energy savings of $73,372 per year accounting for 38% of the total benefits they provide. Stormwater interception and reductions in CO_2 are also important benefits but account for lesser amounts of work performed by community trees. The city's trees intercepted over 1.7 million gallons of rainfall each year, which equates to a savings of $14,019 in stormwater management costs. Stormwater management comprises 7% of the annual benefits. The urban forest positively impacted the air quality of the city with $11,399 saved annually in pollution reduction. This effect accounted for 6% of the total benefits and is discussed in detail in the Air Quality Benefit section. Lastly, CO_2 reductions accounted for $1,553 or approximately 1% of the annual benefits in CO_2 avoidance and sequestration.

Figure 8 summarizes the annual benefits and results for the street tree population. Table 4 presents results for individual tree species from the i-Tree Streets analysis.

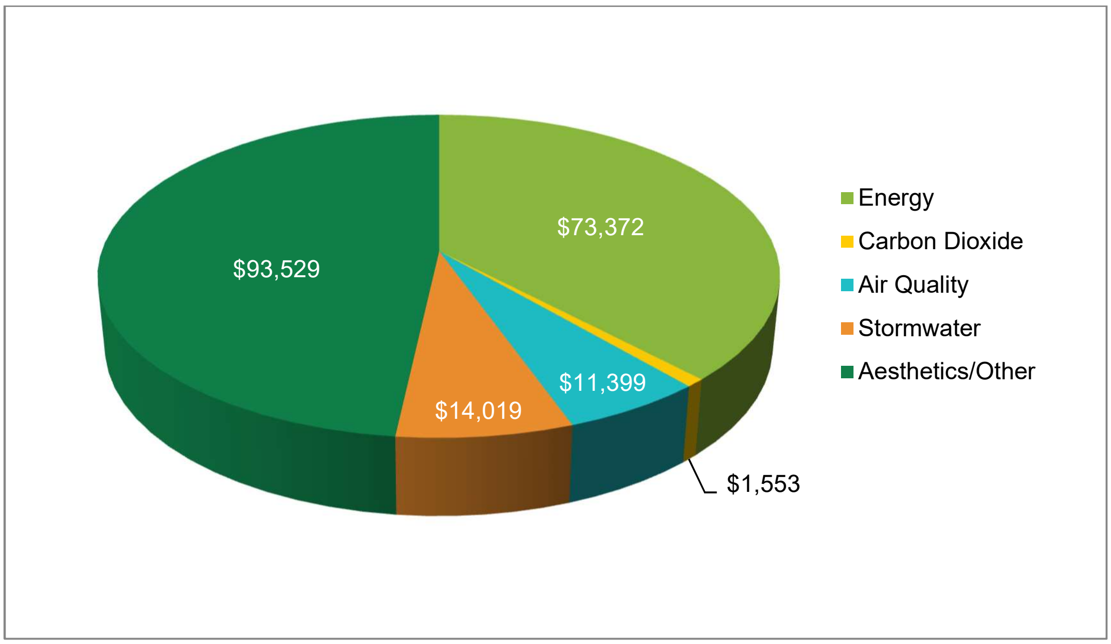


Figure 8. Breakdown of total annual benefits provided to Hamtramck.

Aesthetic/Other Benefits

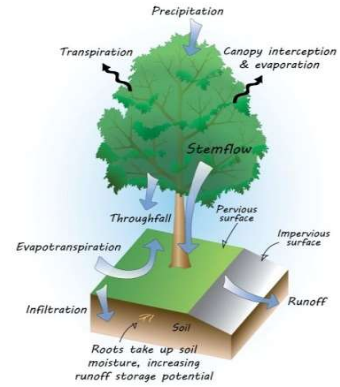
The total annual benefit associated with property value increases and other tangible and intangible benefits of street trees was $93,529. The average benefit per tree was $48.94 per year.

Energy Benefits

Hamtramck's trees conserve energy by shading structures and surfaces, which reduces electricity use for air conditioning in the summer. In the winter, these same trees divert wind and reduce natural gas use. Based on the inventory data, the annual electric and natural gas savings are equivalent to approximately 110 megawatt-hours (MWh) of electricity and 41,189 therms (thm) of natural gas, which accounts for an annual savings of $73,372 in energy consumption. On average, each tree provides $38.39 in benefits through CO_2 storage and sequestration.

Stormwater Benefits

Trees intercept rainfall, which helps lower costs to manage stormwater runoff. The inventoried trees in Hamtramck intercept over 1.7 million gallons of rainfall each year valued at $14,019 annually. On average, the estimated annual savings for the city in stormwater runoff management is $7.34 per tree.



- *Trees reduce stormwater runoff by capturing and storing rainfall in their canopy and releasing water into the atmosphere.*
- *Tree roots and leaf litter create soil conditions that promote the infiltration of rainwater into the soil.*
- *Trees help slow down and temporarily store runoff and reduce pollutants by absorbing nutrients and other pollutants from soils and water through their roots.*
- *Trees transform pollutants into less harmful substances.*

Air Quality Improvements

The inventoried tree population annually removes 1,859 pounds of air pollutants (including ozone, nitrogen dioxide, sulfur dioxide, and particulate matter). The i-Tree Streets calculation considers the biogenic volatile organic compounds (BVOC's) that are released from trees in this calculation. While trees do a great deal to absorb air pollutants, they also contribute negatively to air pollution. Trees emit various BVOCs such as isoprenes and monoterpenes, which can also contribute to formation of ozone, a harmful gas that pollutes the air and damages vegetation. The net total value of these benefits is estimated to be $11,399. The inventoried trees removed or avoided more pollutants than they emitted, resulting in a positive economic value. On average, each tree provides $5.97 in air quality improvement benefits.

i-Tree Tools

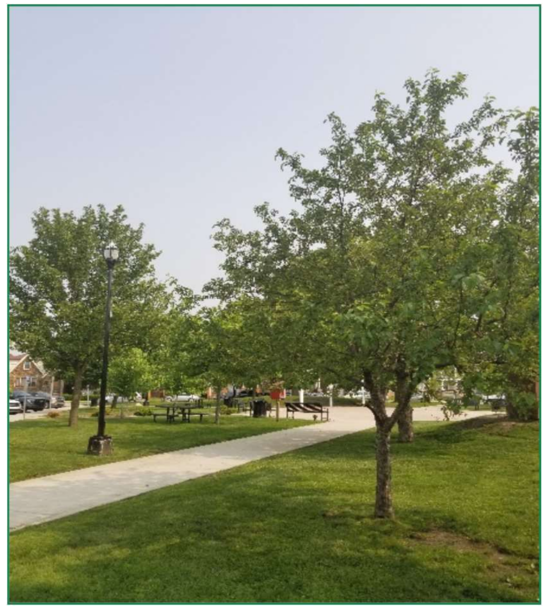
A common example of a natural BVOC is the gas emitted from pine trees, which creates the distinct smell of a pine forest.

Carbon Storage and Carbon Sequestration

Trees store some of the carbon dioxide (CO_2) they absorb preventing it from reaching the upper atmosphere, where it can react with other compounds and form harmful gases like ozone, which adversely affects air quality. These trees also sequester some of the CO_2 during growth (Nowak et al. 2013).

The i-Tree Streets calculation considers the carbon emissions that are *not* released from power stations due to the heating and cooling effect of trees (i.e., conserved energy in buildings and homes). It also calculates emissions released during tree care and maintenance, such as driving to the site and operating equipment. The net carbon benefit is approximately $1,553 per year.

The city's trees store 121 tons of carbon (measured in CO_2 equivalents). This amount reflects the amount of carbon they have amassed during their lifetimes. An additional 140 tons of CO_2 per year are mitigated through avoidance. On average, each tree provides $0.81 in benefits through CO_2 storage and sequestration.



Photograph 4. *Trees improve quality of life and help enhance the character of a community. Trees filter air, water, and sunlight, moderate local climate, slow wind and stormwater, shade homes, and provide shelter to animals and recreational areas for people.*

Discussion/Recommendations

The i-Tree Streets analysis found that Hamtramck's trees provide environmental and economic benefits to the community by virtue of merely being present. Currently, the aesthetic/other benefits provided by the trees were rated as having the greatest value to the community. The property value increase provided by trees is important to stimulate economic growth. In addition to increasing aesthetics and property values, trees provide shade and windbreaks to reduce energy usage, manage stormwater through rainfall interception, and store and sequester CO_2. Singularly these environmental benefits were not found to be as great as the aesthetic/other benefits, but together they form the majority of the benefits.

To increase the benefits the urban forest provides, Hamtramck should plant young, large-statured tree species that are low emitters of BVOCs where growth space size allows. Leafy, large-stature trees consistently created the most environmental and economic benefits. The following list of tree species is used for improving air quality (ICLEI 2006):

- *Betula nigra* (river birch)
- *Celtis laevigata* (sugar hackberry)
- *Fagus grandifolia* (American beech)
- *Metasequoia glyptostroboides* (dawn redwood)
- *Tilia cordata* (littleleaf linden)
- *Tilia europea* (European linden)
- *Tilia tomentosa* (silver linden)
- *Ulmus americana* (American elm)
- *Ulmus procera* (English elm)

SECTION 3: TREE MANAGEMENT PROGRAM

The tree management program was developed to uphold Hamtramck's vision for preserving its urban forest. Utilizing data from the tree inventory, this five-year program was designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles. Tree planting to mitigate removals and increase canopy cover and public outreach are important parts of the program as well.

While implementing a tree care program is an ongoing process, tree work must always be prioritized to reduce public safety risks. DRG recommends completing the work identified during the inventory based on the assigned risk rating and continuing to routinely monitor the tree population to identify other Extreme or High Risk trees and systematically addressing them. While regular pruning cycles and tree planting are important, priority work, especially for Extreme or High Risk trees, must sometimes take precedence to ensure that risk is expediently managed.

Priority and Proactive Maintenance

In this plan, the recommended tree maintenance activities were divided into either priority or proactive maintenance. Priority maintenance includes tree removals and pruning of trees with an assessed risk rating of Extreme, High, or Moderate. Proactive tree maintenance includes pruning of trees with an assessed risk of Low, and trees with a primary maintenance recommendation of Discretionary or Young Tree Training. Tree planting, inspections, and community outreach are also considered proactive maintenance.

Extreme Risk
- Perform tree maintenance immediately to reduce hazards
- Includes tree removal and pruning
- Mostly high-use areas

High Risk
- Perform tree maintenance immediately to reduce hazards and improve tree health
- Includes tree removal and pruning
- Generally high-use areas

Moderate Risk
- Perform tree maintenance as soon as possible to improve tree health
- Includes tree removal and pruning
- May be high- or low-use areas

Low Risk
- Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance trees and stumps
- Includes tree removals and pruning
- Mostly low-use areas but may be high-use areas as well

Routine Pruning
- Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance trees
- Perform corrective pruning to young trees to increase structural integrity and develop a strong architecture of branches before serious problems develop

Tree and Stump Removal

Although tree removal is usually considered a last resort and may sometimes lead to negative reactions from the community, there are circumstances in which removal is necessary. Trees fail from natural causes, such as diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. DRG recommends that trees be removed when corrective pruning will not adequately eliminate the hazard or when correcting problems would be cost-prohibitive. Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Diseased and nuisance trees also warrant removal.

While large, short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Their expedient removal reduces risk and improves public safety.

Figure 9 presents the city's tree removals by risk rating and diameter size class. The following sections briefly summarize the recommended removals identified during the inventory.

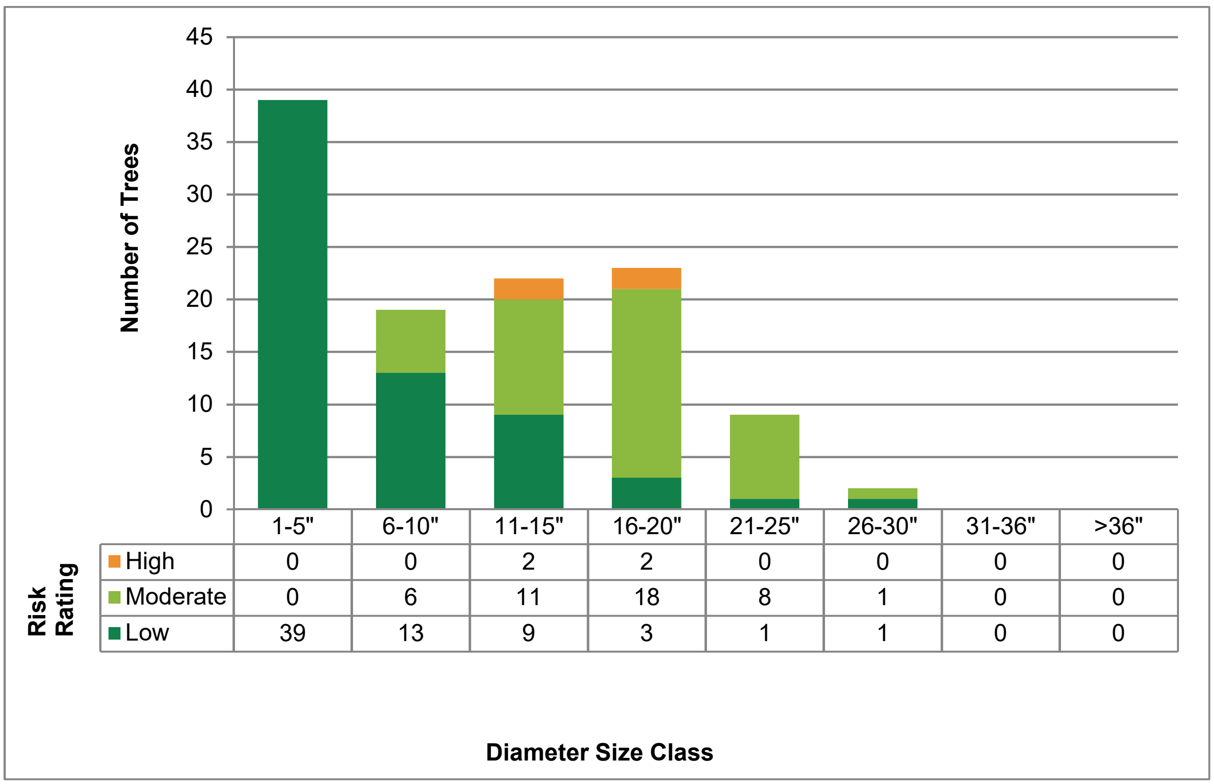


Figure 9. Tree removals by risk rating and diameter size class.

Findings

The inventory identified 0 Extreme Risk trees, 4 High Risk trees, 44 Moderate Risk trees, and 66 Low Risk trees that are recommended for removal.

The diameter size classes for High Risk trees ranged between 11–15 inches diameter at breast height (DBH) and 16–20 inches DBH. These trees should be removed immediately based on their assigned risk. While no Extreme Risk trees were identified in the inventory, in the future, if Extreme Risk trees are identified, their removal and pruning can be performed concurrently with High Risk tree removals and pruning.

Most Moderate Risk trees were smaller than 25 inches DBH. These trees should be removed as soon as possible after all Extreme and High Risk removals and pruning have been completed.

Low Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects and diseases and increase the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category. All Low Risk trees should be removed when convenient and after all High and Moderate Risk removals and pruning have been completed.

The inventory identified 116 stumps recommended for removal. Stump removals should occur when convenient.

Discussion/Recommendations

Unless already slated for removal, trees noted as having ‘improper pruning’, ‘root damage’, ‘mechanical damage’, or similar comments should be inspected on a regular basis. Corrective action should be taken when warranted, and if their condition worsens, removal may be required. Proactive tree maintenance that actively mitigates elevated-risk situations should be completed to promote public safety.

Regularly maintaining and updating the tree inventory data can streamline workload management and lend insight into setting accurate budgets and staffing levels. Inventory updates should be made electronically and can be implemented using TreeKeeper® 8 or similar computer software.

Tree Pruning and Young Tree Training

Pruning trees generally requires cleaning the canopy of both small and large branches to remove defects such as dead and/or broken branches that may be present even when the rest of the tree is sound. In these cases, pruning the branch or branches can correct the problem and reduce risk associated with the tree.

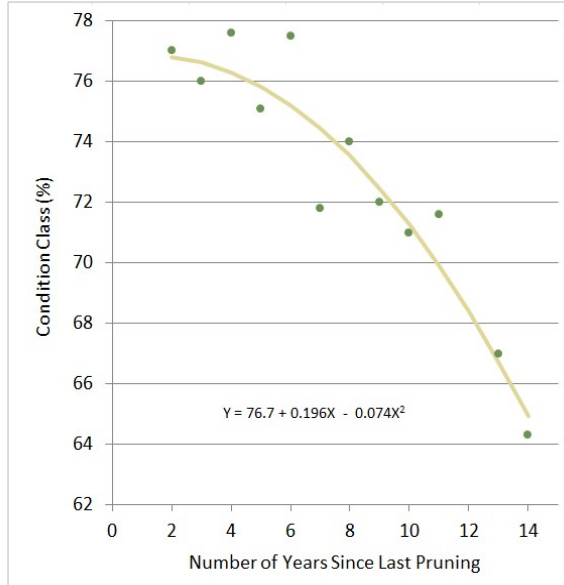


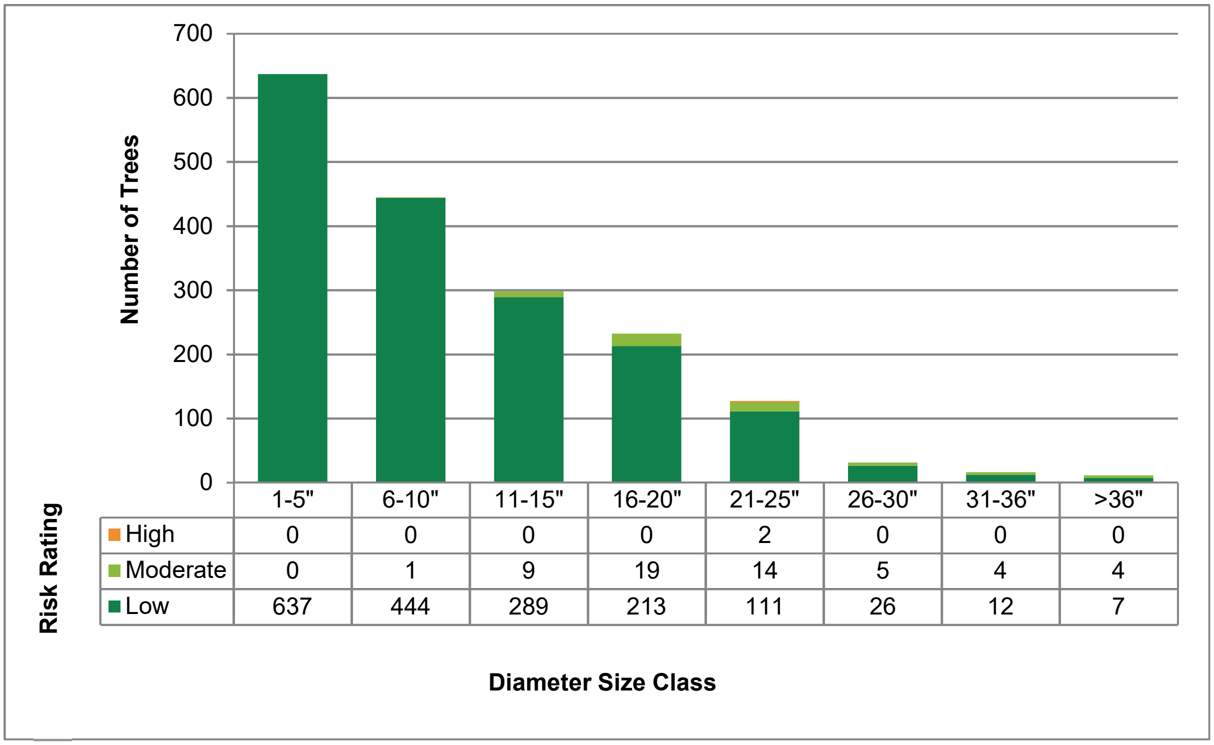
Figure 10. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981).

For many communities, a proactive tree management program might be present a considerable challenge, as an on-demand response to urgent situations is the norm. Research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population (Miller and Sylvester 1981). Proactive tree maintenance has many advantages over on-demand maintenance, the most significant of which is reduced risk. In a proactive program, trees are regularly assessed and pruned, which helps detect and eliminate most defects before they impact the tree's structure and/or escalate to a hazardous situation with an unacceptable level of risk. Other advantages of a proactive program include increased environmental and economic benefits from trees, more predictable budgets and projectable workloads, and reduced long-term tree maintenance costs.

Why Prune Trees on a Cycle?

Miller and Sylvester (1981) examined the frequency of pruning for 40,000 street and boulevard trees in Milwaukee, Wisconsin. They documented a decline in tree health as the length of the pruning cycle increased. When pruning was not completed for more than 10 years, the average tree condition was rated 10% lower than when trees had been pruned within the last several years. Miller and Sylvester suggested that a pruning cycle of five years is optimal for urban trees.

Figure 11 presents the number of trees recommended for pruning and young tree training by risk rating and diameter size class. The following sections briefly summarize the recommended pruning maintenance identified during the inventory.



Risk Rating	1-5"	6-10"	11-15"	16-20"	21-25"	26-30"	31-36"	>36"
High	0	0	0	0	2	0	0	0
Moderate	0	1	9	19	14	5	4	4
Low	637	444	289	213	111	26	12	7

Figure 11. Tree pruning and training by risk rating and diameter size class.

Findings

The inventory identified 0 Extreme Risk trees, 2 High Risk trees, 56 Moderate Risk trees, and 1,739 Low Risk trees recommended for either pruning (including Discretionary Prune) or young tree training.

High Risk trees ranged in diameter of 21–25 inches DBH. Pruning of these trees should be performed immediately based on assigned risk and can be performed concurrently with the High Risk removals and pruning. Moderate Risk pruning work should also take priority and be performed before the routine pruning cycle.

Low Risk trees recommended for pruning should be included in the proactive, routine pruning cycle, after all the higher risk trees are addressed. Trees identified for discretionary pruning and young tree training should also be included in this cycle.

Discussion/Recommendations

DRG recommends that Hamtramck establish a five-year routine pruning (RP) Cycle in which approximately one-fifth of the tree population is to be pruned each year. The 2019 tree inventory identified approximately 1,797 trees that should be pruned over a five-year RP Cycle. An average of 352 trees should be pruned each year over the course of the cycle. DRG recommends that the RP Cycle begin in Year One of this five-year plan, after all Extreme, High, and Moderate Risk trees are pruned and removed.

Maintenance Schedule

Utilizing data from the 2019 City of Hamtramck tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended to be completed each year. Actual costs were not specified by Hamtramck; therefore, DRG made budget projections using industry knowledge and public bid tabulations for similar communities in Michigan.

This projected budget provides a framework for completing the inventory maintenance recommendations over the next five years. Following this schedule can shift tree care activities from an on-demand, reactive system to a more proactive tree care program.

To implement the maintenance schedule, the city's tree maintenance budget should be no less than $108,897 for the first year of implementation, decreasing over the five-year plan to $91,211 by year five. Annual budget funds are needed to ensure that Extreme, High, and Moderate risk trees are remediated and that the crucial RP Cycle can begin. With proper professional tree care, the safety, health, and beauty of the urban forest will improve.

If routing efficiencies and/or contract specifications allow for the completion of more tree work during a given year, or if the schedule requires changes to meet budgetary or other needs, then it should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands.

Table 2. Estimated Costs for Five-Year Urban Forestry Management Program

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Extreme, High, and Moderate Risk Removals	1-5"	$50	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	6-10"	$75	6	$450	0	$0	0	$0	0	$0	0	$0	$450
	11-15"	$100	13	$1,300	0	$0	0	$0	0	$0	0	$0	$1,300
	16-20"	$125	20	$2,500	0	$0	0	$0	0	$0	0	$0	$2,500
	21-25"	$375	8	$3,000	0	$0	0	$0	0	$0	0	$0	$3,000
	26-30"	$565	1	$565	0	$0	0	$0	0	$0	0	$0	$565
	31-36"	$800	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	>36"	$1,300	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			**48**	**$7,815**	0	$0	0	$0	0	$0	0	$0	**$7,815**
Low Risk Removals	1-5"	$50	0	$0	39	$1,950	0	$0	0	$0	0	$0	$1,950
	6-10"	$75	0	$0	13	$975	0	$0	0	$0	0	$0	$975
	11-15"	$100	0	$0	9	$900	0	$0	0	$0	0	$0	$900
	16-20"	$125	3	$375	0	$0	0	$0	0	$0	0	$0	$375
	21-25"	$375	1	$375	0	$0	0	$0	0	$0	0	$0	$375
	26-30"	$565	1	$565	0	$0	0	$0	0	$0	0	$0	$565
	31-36"	$800	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	>36"	$1,300	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			**5**	**$1,315**	**61**	**$3,825**	0	$0	0	$0	0	$0	**$5,140**
Stump Removals	1-5"	$25	0	$0	0	$0	6	$150	4	$100	3	$75	$325
	6-10"	$35	0	$0	0	$0	10	$350	4	$140	2	$70	$560
	11-15"	$50	0	$0	0	$0	15	$750	10	$500	5	$250	$1,500
	16-20"	$65	0	$0	0	$0	8	$520	6	$390	4	$260	$1,170
	21-25"	$80	0	$0	0	$0	10	$800	7	$560	4	$320	$1,680
	26-30"	$100	0	$0	0	$0	5	$500	4	$400	2	$200	$1,100
	31-35"	$150	0	$0	0	$0	3	$450	3	$450		$0	$900
	>36"	$300	0	$0	0	$0	1	$300	0	$0		$0	$300
Activity Total(s)			0	$0	0	$0	**58**	**$3,820**	**38**	**$2,540**	**20**	**$1,175**	**$7,535**
Extreme, High, and Moderate Risk Pruning	1-5"	$58	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	6-10"	$113	0	$0	1	$113	0	$0	0	$0	0	$0	$113
	11-15"	$183	0	$0	9	$1,647	0	$0	0	$0	0	$0	$1,647
	16-20"	$203	10	$2,030	9	$1,827	0	$0	0	$0	0	$0	$3,857
	21-25"	$253	14	$3,542	2	$506	0	$0	0	$0	0	$0	$4,048
	26-30"	$283	5	$1,415	0	$0	0	$0	0	$0	0	$0	$1,415
	31-36"	$323	4	$1,292	0	$0	0	$0	0	$0	0	$0	$1,292
	>36"	$363	4	$1,452	0	$0	0	$0	0	$0	0	$0	$1,452
Activity Total(s)			**37**	**$9,731**	**21**	**$4,093**	0	$0	0	$0	0	$0	**$13,824**
Routine Pruning (5-year cycle based on Low Risk Pruning, Discretionary Pruning, and Young Tree Training)	1-5"	$58	128	$7,424	128	$7,424	128	$7,424	128	$7,424	128	$7,424	$37,120
	6-10"	$113	89	$10,057	89	$10,057	89	$10,057	89	$10,057	89	$10,057	$50,285
	11-15"	$183	58	$10,614	58	$10,614	58	$10,614	58	$10,614	58	$10,614	$53,070
	16-20"	$203	43	$8,729	43	$8,729	43	$8,729	43	$8,729	43	$8,729	$43,645
	21-25"	$253	23	$5,819	23	$5,819	23	$5,819	23	$5,819	23	$5,819	$29,095
	26-30"	$283	6	$1,698	6	$1,698	6	$1,698	6	$1,698	6	$1,698	$8,490
	31-36"	$323	3	$969	3	$969	3	$969	3	$969	3	$969	$4,845
	>36"	$363	2	$726	2	$726	2	$726	2	$726	2	$726	$3,630
Activity Total(s)			**352**	**$46,036**	**352**	**$46,036**	**352**	**$46,036**	**352**	**$46,036**	**352**	**$46,036**	**$230,180**
Tree Planting	Purchasing	$170	75	$12,750	75	$12,750	75	$12,750	75	$12,750	75	$12,750	$63,750
	Planting	$110	75	$8,250	75	$8,250	75	$8,250	75	$8,250	75	$8,250	$41,250
Activity Total(s)			**150**	**$21,000**	**150**	**$21,000**	**150**	**$21,000**	**150**	**$21,000**	**150**	**$21,000**	**$105,000**
Admin, Legal, Outreach, Training				$10,000		$10,000		$10,000		$10,000		$10,000	$50,000
Inspections and Inventory Updates				$3,000		$3,000		$3,000		$3,000		$3,000	
Infrastructure Repair and Storm Response				$10,000		$10,000		$10,000		$10,000		$10,000	$50,000
Activity Total(s)				**$23,000**		**$23,000**		**$23,000**		**$23,000**		**$23,000**	**$115,000**
Activity Grand Total			**592**		**584**		**560**		**540**		**522**		
Cost Grand Total				**$108,897**		**$97,954**		**$93,856**		**$92,576**		**$91,211**	**$484,494**

Community Outreach

The data collected and analyzed to develop this plan not only provides important information to guide the development of a proactive management program, but it can also be utilized to educate the Hamtramck community about the value of the urban forest and the tree management program. Tree inventory data can be shared with the community to:

- Educate the public on the importance of trees and generate a sense of pride in becoming stewards of their urban forest.
- Help explain and justify necessary priority and proactive tree maintenance activities as well as tree planting and preservation initiatives.
- Guide tree species selection for planting projects with the goals of improving species diversity and limiting the introduction of invasive pests and diseases.
- Advise citizens about threats to their trees and the urban forest (such as granulate ambrosia beetle, Asian long-horned beetle, and gypsy moth).

Photograph 5. *Community outreach and education are a pivotal part of a successful urban forestry program. Fostering an appreciation for trees can help the public understand that trees are assets, not liabilities.*

There are various approaches the city can use to educate and communicate information about the urban forest to the community, including:

- Creating and posting maps on the city website, in parks, or in business areas.
- Developing public service announcements and articles about the benefits of trees.
- Creating educational program about trees, tree care and the benefits trees provide.
- Hosing Arbor Day and Earth Day celebrations that can become annual community traditions.
- Creating signs to hang from public trees that highlight the contribution that tree make to the community.
- Holding a photo contests to highlight trees of Hamtramck and increase awareness of the importance of trees.

Inspections

Inspections are essential to uncovering potential problems with trees and should be performed by a qualified arborist who is trained in the art and science of planting, caring, and maintaining individual trees. Arborists are knowledgeable about the needs of trees and are trained and equipped to provide proper care.

Trees along the street ROW should be regularly inspected and attended to, as needed, based on the inspection findings. When trees need additional or new work, they should be added to the maintenance schedule and budgeted as appropriate. Use of appropriate computer management software such as TreeKeeper® 8 to update inventory data and work records can help in the scheduling and budgeting of needed work. In addition to locating potential new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. Hamtramck has a large population of trees, such as oak and maple that are susceptible to pests and diseases.

Inventory and Plan Updates

DRG recommends that the inventory and management plan be updated using an appropriate computer software program to ensure that the city can sustain its program and accurately project future program and budget needs, including:

- Conducting inspections of trees after all severe weather events. Recording changes in tree condition, maintenance needs, and risk rating in the inventory database. Updating the tree maintenance schedule and acquiring the funds needed to promote public safety. Scheduling and prioritize work based on risk.
- Performing routine inspections of public trees as needed. Windshield surveys (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* (ANSI 2017) will help city staff stay apprised of changing conditions. Updating the tree maintenance schedule and the budget as needed so that identified tree work may be efficiently performed will assist in scheduling and prioritizing work based on risk.
- If the recommended work cannot be completed as suggested in this plan, modifying maintenance schedules and budgets accordingly.
- Updating the inventory database using TreeKeeper® 8 as work is performed; and adding new tree work to the schedule when work is identified through inspections or a citizen call process.
- Re-inventorying the street ROW, and updating all data fields in five years, or a portion of the population (1/5) every year over the course of five years.
- Revising the *Tree Management Plan* after five years when the re-inventory has been completed.

CONCLUSIONS

Every hour of every day, public trees in Hamtramck are supporting and improving the quality of life. The city's public trees provide an annual benefit of $193,872. When properly maintained, these trees will provide numerous environmental, economic, and social benefits that far exceed the time and money invested in their planting, pruning, protection, and removal.

Managing trees in urban areas is often complicated. Navigating the recommendations of experts, the needs of residents, the pressures of local economics and politics, concerns for public safety and liability, physical components of trees, forces of nature and severe weather events, along with the expectation that these issues can be resolved all at once is a considerable challenge.

The city must carefully consider these challenges to fully understand the needs of maintaining an urban forest. With the knowledge and wherewithal to address the needs of the city's trees, Hamtramck is well positioned to thrive. If the management program is successfully implemented, the health and safety of Hamtramck's trees and citizens will be maintained for years to come.

Photograph 6. *The success of Hamtramck's urban forestry program depends on strong leadership both from city staff and the community.*

GLOSSARY

address number (data field): The address number was recorded based on the visual observation by the Davey Resource Group arborist at the time of the inventory of the actual address number posted on a building at the inventoried site. In instances where there was no posted address number on a building or sites were located by vacant lots with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist(s).

Aesthetic/Other Report: The i-Tree Streets Aesthetic/Other Report presents the tangible and intangible benefits of trees reflected by increases in property values in dollars ($).

Air Quality Report: The i-Tree Streets Air Quality Report quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], coarse particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces and reduced emissions from power plants (NO_2, PM_{10}, Volatile Oxygen Compounds [VOCs], SO_2) due to reduced electricity use measured in pounds (lbs.). Also reported are the potential negative effects of trees on air quality due to Biogenic Volatile Organic Compounds (BVOC) emissions.

American National Standards Institute (ANSI): ANSI is a private, nonprofit organization that facilitates the standardization work of its members in the United States. ANSI's goals are to promote and facilitate voluntary consensus standards and conformity assessment systems, and to maintain their integrity.

ANSI A300**:** Tree care performance parameters established by ANSI that can be used to develop specifications for tree maintenance.

arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

Benefit-Cost Ratio (BCR): The i-Tree Streets (BCR) is the ratio of the cumulative benefits provided by the landscape trees, expressed in monetary terms, compared to the costs associated with their management, also expressed in monetary terms.

biogenic volatile organic compounds (BVOC): Gases emitted from trees, like pine trees, which create the distinct smell of a pine forest. When exposed to sunlight in the air, BVOCs react to form tropospheric ozone, a harmful gas that pollutes the air and damages vegetation.

canopy: Branches and foliage that make up a tree's crown.

canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

Carbon Dioxide Report: The i-Tree Streets Carbon Dioxide Report presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use in pounds. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

community forest: see **urban forest**.

condition (data field): The general condition of each tree rated during the inventory according to the following categories adapted from the International Society of Arboriculture's rating system: Good, Fair, Poor, and Dead.

cycle: Planned length of time between vegetation maintenance activities.

defect: See **structural defect**.

diameter: See **tree size**.

diameter at breast height (DBH): See **tree size**.

Discretionary (Primary Maintenance Need): These trees do not harbor a strong defect of concern but may be pruned to manage for tree health or aesthetic appearance.

Energy Report: The i-Tree Streets Energy Report presents the contribution of the urban forest toward conserving energy in terms of reduced natural gas use in winter measured in therms (thm) and reduced electricity use for air conditioning in summer measured in megawatt-hours (MWh).

Extreme Risk tree: Applies in situations where tree failure is "imminent", there is a "high" likelihood of impacting the target, and the consequences of the failure are "severe." In some cases, this may mean immediate restriction of access to the target zone area in order to prevent injury.

failure: In terms of tree management, failure is the breakage of stem or branches, or loss of mechanical support of the tree's root system.

genus: A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

geographic information system (GIS): A technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to provide a better understanding of how it all interrelates.

global positioning system (GPS): GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

site type (data field): Best identifies the type of location where a tree is growing. During the inventory, growth space types were categorized as island, median, open/restricted, open/unrestricted, tree lawn/parkway, unmaintained/natural area, well/pit, and other.

High Risk tree: The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely," or consequences are "severe" and likelihood is "likely." In a population of trees, the priority of High Risk trees is second only to Extreme Risk trees.

invasive, exotic tree: A tree species that is out of its original biological community. Its introduction into an area causes or is likely to cause economic or environmental harm, or harm to human health. An invasive, exotic tree has the ability to thrive and spread aggressively outside its natural range. An invasive species that colonizes a new area may gain an ecological edge since the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat.

inventory: See **tree inventory**.

i-Tree Streets: i-Tree Streets is a street tree management and analysis tool that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits: energy conservation, air quality improvement, CO_2 reduction, stormwater control, and property value increase.

i-Tree Tools: State-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

location (data fields): A collection of data fields collected during the inventory to aid in finding trees, including address number, street name, on street, side value, and park name (if applicable).

Low Risk tree: The Low Risk category applies when consequences are "negligible", and likelihood is "unlikely"; or consequences are "minor", and likelihood is "somewhat likely." Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.

Management Costs: Used in i-Tree Streets, they are the expenditures associated with street tree management presented in total dollars, dollars per tree, and dollars per capita.

mapping coordinate (data field): Helps to locate a tree; X and Y coordinates were generated for each tree using GPS.

Moderate Risk tree: The Moderate Risk category applies when consequences are "minor", and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.

multi stem (data field): Identifies the number of stems or trunks splitting less than 1 foot above ground level.

N/A (risk rating): Equal to zero. It is used only for planting sites and stumps.

Net Annual Benefits: Specific data field for i-Tree Streets. Citywide benefits and costs are calculated according to category and summed. Net benefits are calculated as benefits minus costs.

Nitrogen Dioxide (NO_2): Nitrogen dioxide is a compound typically created during the combustion processes and is a major contributor to smog formation and acid deposition.

ordinance: See **tree ordinance**.

overhead utilities (data field): Shows the presence or absence of primary or secondary electric overhead utilities at the tree site.

Ozone (O_3): A strong-smelling, pale blue, reactive toxic chemical gas with molecules of three oxygen atoms. It is a product of the photochemical process involving the Sun's energy. Ozone exists in the upper layer of the atmosphere as well as at the Earth's surface. Ozone at the Earth's surface can cause numerous adverse human health effects. It is a major component of smog.

Particulate Matter (PM_{10}): A major class of air pollutants consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and mists.

Plant Tree (Primary Maintenance Need): If collected during an inventory, this data field identifies planting sites as small, medium, or large (indicating the ultimate size that the tree will attain), depending on the growth space available and the presence of overhead wires.

Primary Maintenance Need (data field): The type of tree work needed to reduce immediate risk.

Prune (Primary Maintenance Need): Based on *ANSI A300 Standards*, these trees require selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk.

pruning: The selective removal of plant parts to meet specific goals and objectives.

Remove (Primary Maintenance Need): Data field collected during the inventory identifying the need to remove a tree. Trees designated for removal have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have a large percentage of dead crown.

right-of-way (ROW): See **street right-of-way**.

risk: Combination of the probability of an event occurring and its consequence.

risk rating: Level 2 qualitative risk assessment will be performed based on the *International Society of Arboriculture Best Management Practices - Tree Risk Assessment*, Second Edition (E. Thomas Smiley, Nelda Matheny, and Sharon Lilly 2017). Trees can have multiple failure modes with various risk ratings. One risk rating per tree will be assigned during the inventory. The failure mode having the greatest risk will serve as the overall tree risk rating. The specified time period for the risk assessment is one year.

side value (data field): Each site is assigned a side value to aid in locating the site. Side values include *front*, *side to*, *side away*, *median* (includes islands), and *rear* based on the site's location in relation to the lot's street frontage. The *front* side is the side that faces the address street. *Side to* is the name of the street the arborist is walking towards as data are being collected. The *side from* is the name of the street the arborist is walking away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

species: Fundamental category of taxonomic classification, ranking below a genus or subgenus, and consisting of related organisms capable of interbreeding.

stem: A woody structure bearing buds and foliage and giving rise to other stems.

Stored Carbon Report: While the i-Tree Streets Carbon Dioxide Report quantifies annual CO_2 reductions, the i-Tree Streets Stored Carbon Report tallies all of the Carbon (C) stored in the urban forest over the life of the trees as a result of sequestration measured in pounds as the CO_2 equivalent.

Stormwater Report: A report generated by i-Tree Streets that presents the reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons (gals.).

street name (data field): The name of a street right-of-way or road identified using posted signage or parcel information.

street right-of-way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

street tree: A street tree is defined as a tree within the right-of-way.

structural defect: A feature, condition, or deformity of a tree or tree part that indicates weak structure and contributes to the likelihood of failure.

Stump Removal (Primary Maintenance Need): Indicates a stump that should be removed.

Sulfur Dioxide (SO_2): A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Sulfur oxides contribute to the problem of acid rain.

Summary Report: A report generated by i-Tree Streets that presents the annual total of energy, stormwater, air quality, carbon dioxide, and aesthetic/other benefits. Values are reflected in dollars per tree or total dollars.

topping: Characterized by reducing tree size using internodal cuts without regard to tree health or structural integrity; this is not an acceptable pruning practice.

Train (Primary Maintenance Need): Data field based on *ANSI A300* standards, this maintenance activity is characterized by pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees can be up to 20 feet tall and can be worked with a pole pruner by a person standing on the ground.

tree: A tree is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms.

tree benefit: An economic, environmental, or social improvement that benefits the community and results mainly from the presence of a tree. The benefit received has real or intrinsic value associated with it.

tree inventory: Comprehensive database containing information or records about individual trees typically collected by an arborist.

tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed urban forest. Tree ordinances simply provide the authorization and standards for management activities.

tree size (data field): A tree's diameter measured to the nearest inch in 1-inch size classes at 4.5 feet above ground, also known as diameter at breast height (DBH) or diameter.

urban forest: All of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, in parks and greenspaces, in forests, and on private property.

Volatile Organic Compounds (VOCs): Hydrocarbon compounds that exist in the ambient air and are by-products of energy used to heat and cool buildings. Volatile organic compounds contribute to the formation of smog and/or are toxic. Examples of VOCs are gasoline, alcohol, and solvents used in paints.

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APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

DRG collected tree inventory data using an internally developed computer-based system, Rover, loaded onto pen-based field computers equipped with geographic information system (GIS) and global positioning system (GPS) receivers. The data collected in this system were uploaded into DRG's TreeKeeper® 8 system for quality assurance and delivery. The knowledge and professional judgment of DRG's arborists ensure the high quality of inventory data.

Data fields are defined in the glossary of the management plan. At each site, the following data fields were collected:

• comments	• risk assessment
• condition	• risk rating
• location*	• site type
• mapping coordinates	• species
• overhead utilities	• tree size**
• primary maintenance needs	

* multiple data fields including address number, street name, on street, side value, and park name (if applicable).

** measured to the nearest inch in diameter at 4.5 feet above ground (or diameter at breast height [DBH]) and if the tree had multiple stems or trunks splitting less than 1 foot above ground level.

Maintenance needs are based on *ANSI A300 (Part 1)* (ANSI 2017). Risk assessment and risk rating are based on the *ANSI A300 (Part 9)* (ANSI 2017), and the companion publication *Best Management Practices: Tree Risk Assessment* (ISA 2017).

The data collected were uploaded and presented on Hamtramck's TreeKeeper® 8 website and exported as an Esri shapefile.

Site Location Methods

Equipment and Base Maps

Inventory arborists used FZ-G1 Panasonic Toughpad® units equipped with internal GPS receivers.

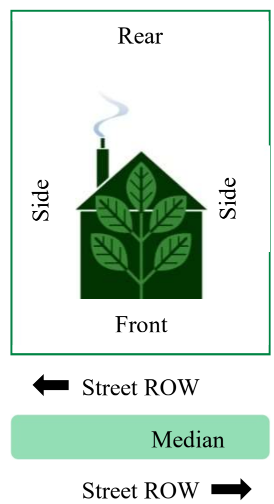
Base map layers were loaded onto these units to help locate sites during the inventory. The table below lists the base map layers, utilized along with source and format information for each layer.

Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
Nearmap Inc Aerial Imagery	2019	NAD 1983 StatePlane Michigan South; Feet
Michigan Open Data portal http://gis-michigan.opendata.arcgis.com/search?tags=boundaries	2018-2019	NAD 1983 StatePlane Michigan South; Feet
Parcel Data City of Hamtramck Assessors Office (Jay Singh)	2019	NAD 1983 StatePlane Michigan South; Feet

Street ROW Site Location

Individual street ROW sites (trees, stumps, or planting sites) were located using a methodology that identifies sites by *address number*, *street name,* and *side value*. This methodology was developed by DRG to help ensure consistent assignment of location.



Side values for street ROW sites.

Address Number and Street Name

The *address number* was recorded based on visual observation by the arborist at the time of the inventory (the address number was posted on a building at the inventoried site). Where there was no posted address number on a building, or where the site was located by a vacant lot with no GIS parcel addressing data available, the arborist used their best judgment to assign an address number based on opposite or adjacent addresses.

Sites in medians or islands were assigned an address number using the address on the right side of the street in the direction of collection closest to the site. Each segment was numbered with an assigned address that was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was assigned its own address.

The *street name* assigned to a site was determined by street ROW parcel information and posted street name signage.

Side Value

Each site was assigned a *side value*. Side values include: *front*, *side*, *median* (includes islands), or *rear* based on the site's location in relation to the lot's street frontage. The *front* is the side that faces the address street. *Sides* are the name of the street the arborist walks towards or away from as data are being collected. *Median* indicates a median or island. The *rear* is the side of the lot opposite the *front*.

Park and/or Public Space Site Location

Park and/or public space site locations were collected using the same methodology as street ROW sites; however, the *street* and *on street* were recorded as the park and/or public space's address and *side value* was always recorded as *front.*

Site Location Examples

The tree trimming crew in the truck traveling westbound on E. Mac Arthur Street is trying to locate an inventoried tree with the following location information:

Address/Street Name:	226 E. Mac Arthur Street
Side:	Side
On Street:	Davis Street

The tree site circled in red signifies the crew's target site. Because the tree is located on the side of the lot, the *on street* is Davis Street, even though it is addressed as 226 East Mac Arthur Street.

Location information collected for inventoried trees at Corner Lots A and B.

Corner Lot A | **Corner Lot B**

Address/Street Name: 205 Hoover St. | Address/Street Name: 226 E Mac Arthur St.
Side/Site Number: Side | Side/Site Number: Side
On Street: Taft St. | On Street: Davis St.

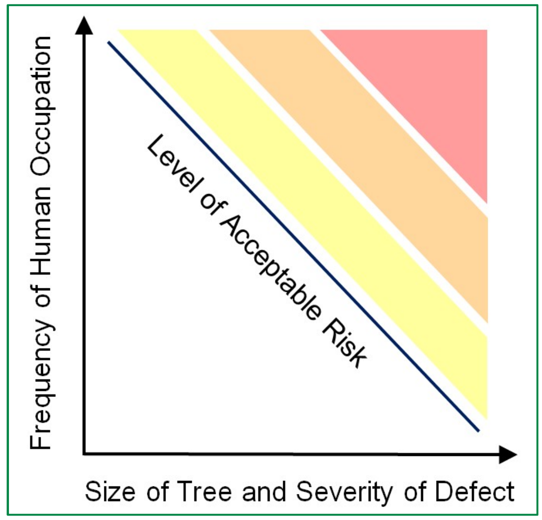
Address/Street Name: 205 Hoover St. | Address/Street Name: 226 E Mac Arthur St.
Side/Site Number: Side | Side/Site Number: Front
On Street: Taft St. | On Street: E Mac Arthur St.

Address/Street Name: 205 Hoover St. | Address/Street Name: 226 E Mac Arthur St.
Side/Site Number: Side | Side/Site Number: Front
On Street: Taft St. | On Street: E Mac Arthur St.

Address/Street Name: 205 Hoover St.
Side/Site Number: Front
On Street: Hoover St.

APPENDIX B
RISK ASSESSMENT/PRIORITY AND PROACTIVE MAINTENANCE

Risk Assessment



Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, DRG performed a Level 2 qualitative risk assessment for each tree and assigned a risk rating based on the *ANSI A300 (Part 9)* (ANSI 2017)*,* and the companion publication *Best Management Practices: Tree Risk Assessment* (ISA 2017). Trees can have multiple failure modes with various risk ratings. One risk rating per tree will be assigned during the inventory. The failure mode having the greatest risk will serve as the overall tree risk rating. The specified time period for the risk assessment is one year.

- **Likelihood of Failure**—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.
  - Improbable—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.
  - Possible—Failure could occur but is unlikely during normal weather conditions within the specified time period.
  - Probable—Failure may be expected under normal weather conditions within the specified time period.
- **Likelihood of Impacting a Target**—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls towards the target.
  - Very low—The chance of the failed tree or branch impacting the target is remote.
    - Rarely used sites
    - Examples include rarely used trails or trailheads
    - Instances where target areas provide protection
  - Low—It is not likely that the failed tree or branch will impact the target.
    - Occasional use area fully exposed to tree
    - Frequently used area partially exposed to tree
    - Constant use area that is well protected

- Medium—The failed tree or branch may or may not impact the target.
  - Frequently used areas that are partially exposed to the tree on one side
  - Constantly occupied area partially protected from the tree
- High—The failed tree or branch will most likely impact the target.
  - Fixed target is fully exposed to the tree or tree part

- **Categorizing Likelihood of Tree Failure Impacting a Target**—The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

- **Consequence of Failure**—The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.
  - Negligible—Consequences involve low value damage and do not involve personal injury.
    - Small branch striking a fence
    - Medium-sized branch striking a shrub bed
    - Large tree part striking structure and causing monetary damage
    - Disruption of power to landscape lights
  - Minor—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.
    - Small branch striking a house roof from a high height
    - Medium-sized branch striking a deck from a moderate height
    - Large tree part striking a structure, causing moderate monetary damage
    - Short-term disruption of power at service drop to house
    - Temporary disruption of traffic on neighborhood street
  - Significant—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.
    - Medium-sized part striking a vehicle from a moderate or high height
    - Large tree part striking a structure resulting in high monetary damage
    - Disruption of distribution of primary or secondary voltage power lines, including individual services and street-lighting circuits
    - Disruption of traffic on a secondary street

- Severe—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.
  - Injury to a person that may result in hospitalization
  - Medium-sized part striking an occupied vehicle
  - Large tree part striking an occupied house
  - Serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways

- **Risk Rating**—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.

Likelihood of Failure	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Trees have the potential to fail in more than one way and can affect multiple targets.

Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

- None—Used for planting and stump sites only.
- Low—The Low Risk category applies when consequences are "negligible" and likelihood is "unlikely"; or consequences are "minor" and likelihood is "somewhat likely." Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.
- Moderate—The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.
- High—The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely," or consequences are "severe" and likelihood is "likely." In a population of trees, the priority of High Risk trees is second only to Extreme Risk trees.
- Extreme—The Extreme Risk category applies in situations where tree failure is "imminent" and there is a "high" likelihood of impacting the target, and the consequences of the failure are "severe." In some cases, this may mean immediate restriction of access to the target zone area to avoid injury to people.

Trees with elevated (Extreme or High) risk levels are usually recommended for removal or pruning to eliminate the defects that warranted their risk rating. However, in some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. DRG recommends only removal or pruning to alleviate risk. But in special situations, such as a memorial tree or a tree in a historic area, the city may decide that cabling, bracing, or moving the target may be the best option for reducing risk.

Determination of acceptable risk ultimately lies with city managers. Since there are inherent risks associated with trees, the location of a tree is an important factor in the determination and acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency of human occupation increases in the vicinity of the tree. For example, a tree located next to a heavily traveled street will have a higher level of risk than a similar tree in an open field.

Priority Maintenance

Identifying and ranking the maintenance needs of a tree population enables tree work to be assigned priority based on observed risk. Once prioritized, tree work can be systematically addressed to eliminate the greatest risk and liability first (Stamen 2011).

Risk is a graduated scale that measures potential tree-related hazardous conditions. A tree is considered hazardous when its potential risks exceed an acceptable level. Managing trees for risk reduction provides many benefits, including:

- Lower frequency and severity of accidents, damage, and injury
- Less expenditure for claims and legal expenses
- Healthier, long-lived trees
- Fewer tree removals over time
- Lower tree maintenance costs over time

Regularly inspecting trees and establishing tree maintenance cycles generally reduce the risk of failure, as problems can be found and addressed before they escalate.

In this plan, all tree removals and Extreme, High, and Moderate Risk prunes are included in the priority maintenance program.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. Tree work is typically performed during a cycle. Individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest, as every tree in the inventoried population is regularly visited, assessed, and maintained. DRG recommends proactive tree maintenance that includes pruning cycles, inspections, and planned tree planting.

APPENDIX C
RECOMMENDED SPECIES FOR FUTURE PLANTING

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the soil and climate conditions throughout Zone 6 on the USDA Plant Hardiness Zone Map.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	Red Sunset®
Acer saccharum	sugar maple	'Legacy'
*Aesculus flava**	yellow buckeye	
*Betula alleghaniensis**	yellow birch	
*Betula lenta**	sweet birch	
Betula nigra	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
*Carya illinoensis**	pecan	
*Carya lacinata**	shellbark hickory	
*Carya ovata**	shagbark hickory	
*Castanea mollissima**	Chinese chestnut	
Celtis laevigata	sugar hackberry	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	katsuratree	'Aureum'
*Diospyros virginiana**	common persimmon	
*Fagus grandifolia**	American beech	
*Fagus sylvatica**	European beech	(Numerous exist)
Ginkgo biloba	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	'Shademaster'
Gymnocladus dioica	Kentucky coffeetree	Prairie Titan®
*Juglans nigra**	black walnut	
*Larix decidua**	European larch	
Liquidambar styraciflua	American sweetgum	'Rotundiloba'
*Liriodendron tulipifera**	tuliptree	'Fastigiatum'
*Magnolia acuminata**	cucumbertree magnolia	(Numerous exist)
*Magnolia macrophylla**	bigleaf magnolia	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
*Platanus occidentalis**	American sycamore	
Platanus × acerifolia	London planetree	'Yarwood'
Quercus alba	white oak	

Large Trees: Greater than 45 Feet in Height at Maturity (Continued)

Scientific Name	Common Name	Cultivar
Quercus bicolor	swamp white oak	
Quercus coccinea	scarlet oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus montana	chestnut oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus imbricaria	shingle oak	
Quercus phellos	willow oak	
Quercus robur	English oak	Heritage®
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	Shumard oak	
Styphnolobium japonicum	Japanese pagodatree	'Regent'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia americana	American linden	'Redmond'
Tilia cordata	littleleaf linden	'Greenspire'
Tilia × euchlora	Crimean linden	
Tilia tomentosa	silver linden	'Sterling'
Ulmus parvifolia	Chinese elm	Allée®
Zelkova serrata	Japanese zelkova	'Green Vase'

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus × carnea	red horsechestnut	
Alnus cordata	Italian alder	
*Asimina triloba**	pawpaw	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	amur corktree	'Macho'
Pistacia chinensis	Chinese pistache	
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
*Sassafras albidum**	sassafras	

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum	trident maple	Streetwise®
Acer campestre	hedge maple	Queen Elizabeth™
Acer cappadocicum	coliseum maple	'Aureum'
Acer ginnala	amur maple	Red Rhapsody™
Acer griseum	paperbark maple	
Acer nigrum	black maple	
*Acer pensylvanicum**	striped maple	
Acer triflorum	three-flower maple	
*Aesculus pavia**	red buckeye	
Amelanchier arborea	downy serviceberry	(Numerous exist)
Amelanchier laevis	Allegheny serviceberry	
*Carpinus caroliniana**	American hornbeam	
Cercis canadensis	eastern redbud	'Forest Pansy'
Chionanthus virginicus	white fringetree	
Cornus alternifolia	pagoda dogwood	
Cornus kousa	Kousa dogwood	(Numerous exist)
Cornus mas	cornelianchery dogwood	'Spring Sun'
Corylus avellana	European filbert	'Contorta'
*Cotinus coggygria**	common smoketree	'Flame'
*Cotinus obovata**	American smoketree	
*Crataegus phaenopyrum**	Washington hawthorn	Princeton Sentry™
Crataegus viridis	green hawthorn	'Winter King'
*Franklinia alatamaha**	Franklinia	
*Halesia tetraptera**	Carolina silverbell	'Arnold Pink'
Laburnum × watereri	goldenchain tree	
Maackia amurensis	amur maackia	
*Magnolia × soulangiana**	saucer magnolia	'Alexandrina'
*Magnolia stellata**	star magnolia	'Centennial'
*Magnolia tripetala**	umbrella magnolia	
*Magnolia virginiana**	sweetbay magnolia	Moonglow®
Malus spp.	flowering crabapple	(Disease resistant only)
Oxydendrum arboreum	sourwood	'Mt. Charm'
Prunus subhirtella	Higan cherry	'Pendula'
Prunus virginiana	common chokecherry	'Schubert'
*Staphylea trifolia**	American bladdernut	
Stewartia ovata	mountain stewartia	
*Styrax japonicus**	Japanese snowbell	'Emerald Pagoda'
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Note: * denotes species that are **not** recommended for use as street trees.

Coniferous and Evergreen Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies balsamea	balsam fir	
Abies concolor	white fir	'Violacea'
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
× *Cupressocyparis leylandii*	Leyland cypress	
Ilex opaca	American holly	
Picea omorika	Serbian spruce	
Picea orientalis	oriental spruce	
Pinus densiflora	Japanese red pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Pinus taeda	loblolly pine	
Pinus virginiana	Virginia pine	
Psedotsuga menziesii	Douglas-fir	
Thuja plicata	western arborvitae	(Numerous exist)
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Chamaecyparis thyoides	atlantic whitecedar	(Numerous exist)
Juniperus virginiana	eastern redcedar	
Pinus bungeana	lacebark pine	
Pinus flexilis	limber pine	
Pinus parviflora	Japanese white pine	
Thuja occidentalis	eastern arborvitae	(Numerous exist)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Ilex × attenuata	Foster's holly	
Pinus aristata	bristlecone pine	
Pinus mugo mugo	mugo pine	

Dirr's Hardy Trees and Shrubs (Dirr 2013) and *Manual of Woody Landscape Plants (5th Edition)* (Dirr 1988) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on DRG's experience. Tree availability will vary based on availability in the nursery trade.

APPENDIX D
TREE PLANTING

Tree Planting

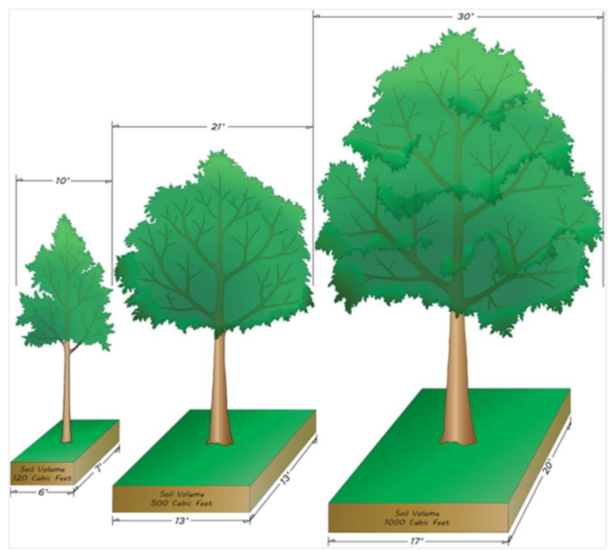
Planting trees is a valuable goal as long as tree species are carefully selected and correctly planted. When trees are planted, they are planted selectively and with purpose. Without proactive planning and follow-up tree care, a newly planted tree may become a future problem instead of a benefit to the community.

When planting trees, it is important to be cognizant of the following:

- Consider the specific purpose of the tree planting.
- Assess the site and know its limitations (i.e., confined spaces, overhead wires, and/or soil type).
- Select the species or cultivar best suited for the site conditions.
- Examine trees before buying them and buy for quality.

Street ROW Planting Spaces

The goal of tree planting is to have a vigorous, healthy tree that lives to the limits of its natural longevity. That can be difficult to achieve in an urban growing environment because of limited irrigation and poor-quality soils. However, proper planning, species selection, tree planting techniques, and follow-up tree maintenance will improve the chance of tree planting success.



Minimum recommended requirements for tree sites is based on tree size/dimensions. This illustration is based on the work of Casey Trees (2008).

Tree Species Selection

Selecting a limited number of species could simplify decision-making processes; however, careful deliberation and selection of a wide variety of species is more beneficial and can save money. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population. This reduces time and money spent to mitigate pest- or disease-related problems. A wide variety of tree species can help limit the impacts from physical events, as different tree species react differently to stress. Species diversity helps withstand drought, ice, flooding, strong storms, and wind.

Hamtramck is in USDA Hardiness Zone 6b which is identified as a climatic region with average annual minimum temperatures between −5°F and 0°F. Tree species selected for planting in Hamtramck should be appropriate for this zone.

Tree species should be selected for their durability and low-maintenance characteristics. These attributes are highly dependent upon site characteristics below ground (soil texture, soil structure, drainage, soil pH, nutrients, road salt, and root spacing). Matching a species to its favored soil conditions is the most important task when planning for a low-maintenance landscape. Plants that are well matched to their environmental site conditions are much more likely to resist pathogens and insect pests and will, therefore, require less maintenance overall.

The Right Tree in the Right Place is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Some grow tall, some grow wide, and some have extensive root systems. Before selecting a tree for planting, make sure it is the right tree—know how tall, wide, and deep it will be at maturity. Equally important to selecting the right tree is choosing the right spot to plant it. Blocking an unsightly view or creating some shade may be a priority, but it is important to consider how a tree may impact existing utility lines as it grows taller, wider, and deeper. If the tree's canopy, at maturity, will reach overhead lines, it is best to choose another tree or a different location. Taking the time to consider location before planting can prevent power disturbances and improper utility pruning practices.

A major consideration for street trees is the amount of litter dropped by mature trees. Trees such as *Acer saccharinum* (silver maple) have weak wood and typically drop many small branches during a growing season. Others, such as *Liquidambar styraciflua* (American sweetgum), drop high volumes of fruit. In certain species, such as *Ginkgo biloba* (ginkgo), female trees produce large odorous fruit; male ginkgo trees, however, do not produce fruit. Furthermore, a few species of trees, including *Crataegus* spp. (hawthorn) and *Gleditsia triacanthos* (honeylocust), may have substantial thorns. These species should be avoided in high-traffic areas.

Seasonal color should also be considered when planning tree plantings. Flowering varieties are particularly welcome in the spring, and deciduous trees that display bright colors in autumn can add a great deal of appeal to surrounding landscapes.

DRG recommends limiting the planting of *Acer* (maple) until the species distribution normalizes. Of the inventoried population 43% of the trees were *Acer* (maple).

Tips for Planting Trees

To ensure a successful tree planting effort, the following measures should be taken:

- Handle trees with care. Trees are living organisms and are perishable. Protect trees from damage during transport and when loading and unloading. Use care not to break branches, and do not lift trees by the trunk.
- If trees are stored prior to planting, keep the roots moist.
- Dig the planting hole according to the climate. Generally, the planting hole is two to three times wider and not quite as deep as the root ball. The root flair is at or just above ground level.
- Fill the hole with native soil unless it is undesirable, in which case soil amendments should be added as appropriate for local conditions. Gently tamp and add water during filling to reduce large air pockets and ensure a consistent medium of soil, oxygen, and water.
- Stake the tree as necessary to prevent it from shifting too much in the wind.
- Add a thin layer (1–2 inches) of mulch to help prevent weeds and keep the soil moist around the tree. Do not allow mulch to touch the trunk.

Mulch piled too deep and touching the trunk of the tree will harm and may kill the tree. DRG suggests that any mulch piled up around a tree should be spread out into a thin layer over the growth space and moved away from the trunk.

Newly Planted and Young Tree Maintenance

Caring for trees is just as important as planting them. Once a tree is planted, it must receive maintenance for several years.

Watering

Initially, watering is the key to survival; new trees typically require at least 60 days of watering to establish. Determine how often trees should be irrigated based on time of planting, drought status, species selection, and site condition.

Mulching

Mulch can be applied to the growth space around a newly planted tree (or even a more mature tree) to ensure that no weeds grow, that the tree is protected from mechanical damage, and that the growth space is moist. Mulch should be applied in a thin layer, generally 1 to 2 inches, and the growing area should be covered. Mulch should not touch the tree trunk or be piled up around the tree.

Lifelong Tree Care

After the tree is established, it will require routine tree care, which includes inspections, routine pruning, watering, plant health care, and integrated pest management as needed.

The city should employ qualified arborists to provide most of the routine tree care. An arborist can determine the type of pruning necessary to maintain or improve the health, appearance, and safety of trees. These techniques may include: eliminating branches that rub against each other; removing limbs that interfere with wires and buildings or that obstruct streets, sidewalks, or signage; removing dead, damaged, or weak limbs that pose a hazard or may lead to decay; removing diseased or insect-infested limbs; creating better structure to reduce wind resistance and minimize the potential for storm damage; and removing branches—or thinning—to increase light penetration.

An arborist can help decide whether a tree should be removed and, if so, to what extent removal is needed. Additionally, an arborist can perform—and provide advice on—tree maintenance when disasters such as storms or droughts occur. Storm-damaged trees can often be dangerous to remove or trim. An arborist can assist in advising or performing the job in a safe manner while reducing further risk of damage to property.

Plant Health Care, a preventive maintenance process that keeps trees in good health, helps a tree better defend itself against insects, disease, and site problems. Arborists can help determine proper plant health so that the city's tree population will remain healthy and provide benefits to the community for as long as possible.

Integrated Pest Management is a process that involves common sense and sound solutions for treating and controlling pests. These solutions incorporate basic steps: identifying the problem, understanding pest biology, monitoring trees, and determining action thresholds. The practice of Integrated Pest Management can vary depending on the site and based on each individual tree. A qualified arborist will be able to make sure that the city's trees are properly diagnosed and that a beneficial and realistic action plan is developed.

The arborist can also help with cabling or bracing for added support to branches with weak attachment, aeration to improve root growth, and installation of lightning protection systems.

Educating the community on basic tree care is a good way to promote the city's urban forestry program and encourage tree planting on private property. The city should encourage citizens to water trees on the ROW adjacent to their homes and to reach out to the city if they notice any changes in the trees, such as signs or symptoms of pests, early fall foliage, or new mechanical or vehicle damage.

APPENDIX E
INVASIVE PESTS AND DISEASES THAT AFFECT TREES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in clean-up costs. Keeping these pests and diseases out of the country is the number one priority of the United States Department of Agriculture's (USDA) Animal and Plant Inspection Service (APHIS).

Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in baggage, cargo, contaminants of commodities, or mail.

Once they arrive, hungry pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. The following sections include key pests and diseases that adversely affect trees in America at the time of this plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area and in our country so that you can be prepared to combat their attack.

APHIS, Plant Health, Plant Pest Program Information
- www.aphis.usda.gov/plant_health/plant_pest_info

The University of Georgia, Center for Invasive Species and Ecosystem Health
- www.bugwood.org

USDA National Agricultural Library
- www.invasivespeciesinfo.gov/microbes

USDA Northeastern Areas Forest Service, Forest Health Protection
- www.na.fs.fed.us/fhp

Asian Longhorned Beetle

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

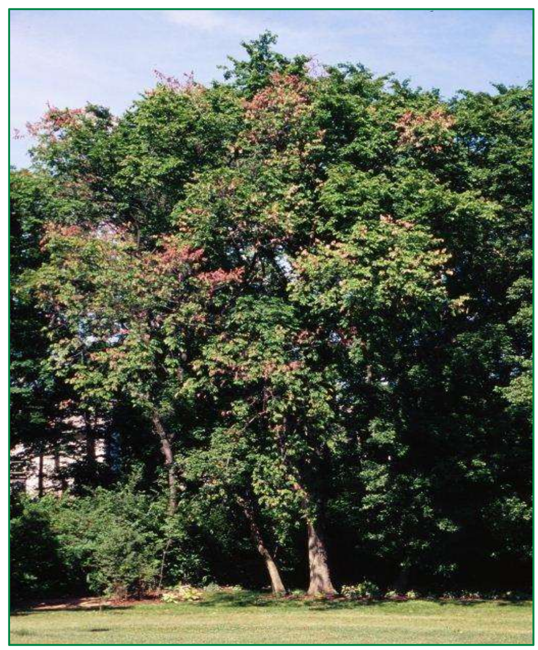
Adult Asian longhorned beetle

Photograph courtesy of New Bedford Guide 2011

Adults are large (3/4- to 1/2-inch long) with very long, black and white banded antennae. The body is glossy black with irregular white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods, including several maple species. Examples include: *Acer negundo* (box elder); *A. platanoides* (Norway maple); *A. rubrum* (red maple); *A. saccharinum* (silver maple); *A. saccharum* (sugar maple); *Aesculus glabra* (buckeye); *A. hippocastanum* (horsechestnut), *Betula* (birch), *Platanus × acerifolia* (London planetree), *Salix* (willow), and *Ulmus* (elm).

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930; by 1933, the disease was present in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Illinois, and annually kills many of the remaining and newly planted elms. The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.



Branch death, or flagging, at multiple locations in the crown of a diseased elm

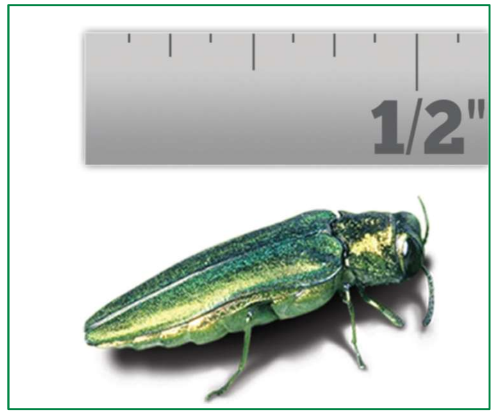
Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

There are two closely-related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, which is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elms by elm bark beetles. Two species carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus)*.

The species most affected by DED is the *Ulmus americana* (American elm).

Emerald Ash Borer

Emerald ash borer *(EAB) (Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, EAB has been found in China, Japan, Korea, Mongolia, eastern Russia, and Taiwan. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002.



Close-up of the emerald ash borer

Photograph courtesy of APHIS (2011)

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread.

The EAB-preferred host tree species are in the genus *Fraxinus* (ash).

Gypsy Moth

The gypsy moth (GM) *(Lymantria dispar*) is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars have an appetite for more than 300 species of trees and shrubs. GM caterpillars defoliate trees, which makes the species vulnerable to diseases and other pests that can eventually kill the tree.

Close-up of male (darker brown) and female (whitish color) European gypsy moths

Photograph courtesy of APHIS (2011b)

Male GMs are brown with a darker brown pattern on their wings and have a 1/2-inch wingspan. Females are slightly larger with a 2-inch wingspan and are nearly white with dark, saw-toothed patterns on their wings. Although they have wings, the female GM cannot fly.

The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: *Betula* (birch), *Juniperus* (cedar), *Larix* (larch), *Populus* (aspen, cottonwood, poplar), *Quercus* (oak), and *Salix* (willow).

Granulate Ambrosia Beetle

Adult granulate ambrosia beetle

Photograph courtesy of Paul M. Choate, University of Florida (Atkinson et al. 2011)

The granulate ambrosia beetle (*Xylosandrus crassiusculus*), formerly the Asian ambrosia beetle, was first found in the United States in 1974 on peach trees near Charleston, South Carolina. The native range of the granulate ambrosia beetle is probably tropical and subtropical Asia. The beetle is globally present in countries such as equatorial Africa, Asia, China, Guinea, Hawaii, India, Japan, New South Pacific, Southeast Indonesia, Sri Lanka, and the United States. In the United States, this species has spread along the lower Piedmont region and coastal plain to East Texas, Florida, Louisiana, and North Carolina. Populations were found in Oregon and Virginia in 1992, and in Indiana in 2002.

Adults are small and have a reddish-brown appearance with a downward facing head. Most individuals have a reddish head region and a dark brown to black elytra (hard casings protecting the wings). Light-colored forms that appear almost yellow have also been trapped. A granulated (rough) region is located on the front portion of the head and long setae (hairs) can be observed on the back end of the wing covers. Females are 2–2.5mm and males are 1.5mm long. Larvae are C-shaped with a defined head capsule.

The granulate ambrosia beetle is considered an aggressive species and can attack trees that are not highly stressed. It is a potentially serious pest of ornamentals and fruit trees and is reported to be able to infest most trees and some shrubs (azalea, rhododendron) but not conifers. Known hosts in the United States include: *Acer* (maple); *Albizia* (albizia); *Carya* (hickory); *Cercis canadensis* (eastern redbud); *Cornus* (dogwood); *Diospyros* (persimmon); *Fagus* (beech); *Gleditsia* or *Robinia* (locust); *Juglans* (walnut); *Koelreuteria* (goldenrain tree); *Lagerstroemia* (crapemyrtle); *Liquidambar styraciflua* (sweetgum); *Liriodendron tulipifera* (tulip poplar); *Magnolia* (magnolia); *Populus* (aspen); *Prunus* (cherry); *Quercus* (oak); and *Ulmus parvifolia* (Chinese elm). *Carya illinoinensis* (pecan) and *Pyrus calleryana* (Bradford pear) are commonly attacked in Florida and in the southeastern United States.

Xm Ambrosia Beetle

Xm ambrosia beetle

Photograph courtesy of Michael C. Thomas, Florida Department of Agriculture and Consumer Services (Rabaglia et al 2003)

The Xm ambrosia beetle (*Xylosandrus mutilatus*), is native to Asia and was first detected in the United States in 1999 in traps near Starkville, Mississippi. By 2002, the beetle spread throughout Missouri and quickly became well-established in Florida. The species also has been found in Alabama, northern Georgia, and Texas. In addition to its prevalence in the southeastern United States, the Xm ambrosia beetle is currently found in China, India, Indonesia, Japan, Korea, Malaya, Myanmar, Papua New Guinea, Sri Lanka, Taiwan, and Thailand.

This species generally targets weakened and dead trees. Since the beetle attacks small diameter material, it may be commonly transported in nursery stock. Female adults are prone to dispersal by air currents and can travel 1–3 miles in pursuit of potential hosts. This active capability results in a broad host range and high probability of reproduction. The species is larger than any other species of *Xylosandrus* (greater than 3 millimeters) in the U.S. and is easily recognized by its steep declivity and dark brown to black elytra (hard casings protecting the wings). Larvae are white and c-shaped with an amber colored head capsule.

Known hosts in the U.S. include: *Acer* (maple); *Albizia* (silktree); *Benzoin* (northern spicebush); *Camellia* (camellia); *Carpinus laxiflora* (looseflower hornbeam); *Castanae* (sweet chestnut); *Cinnamomum camphora* (camphor tree); *Cornus* (dogwood); *Cryptomeria japonica* (Japanese cedar); *Fagus crenata* (Japanese beech); *Lindera erythrocarpa* (spicebush); *Machilus thurnbergii* (Japanese persea); *Ormosia hosiei* (ormosia); *Osmanthus fragrans* (sweet osmanthus); *Parabezion praecox*; *Platycarpa*; and *Sweitenia macrophylla* (mahogany).

Hemlock Woolly Adelgid

Hemlock woolly adelgids on a branch

Photograph courtesy of USDA Forest Service (2011a)

The hemlock woolly adelgid (HWA, *Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern United States in 1951 near Richmond, Virginia.

In their native range, populations of HWA cause little damage to the hemlock trees, as they feed on natural enemies and possible tree resistance has evolved with this insect. In eastern North America and in the absence of natural control elements, HWA attacks both *Tsuga canadensis* (eastern or Canadian hemlock) and *T. caroliniana* (Carolina hemlock), often damaging and killing them within a few years of becoming infested.

The HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee.

Oak Wilt

Oak wilt symptoms on red and white oak leaves

Photograph courtesy of USDA Forest Service (2011a)

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak). It also attacks trees in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oaks and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oaks, but the disease is more commonly spread through root grafts. Oak species within the same subgenus (red or white) will form root colonies with grafted roots that allow the disease to move readily from one tree to another.

Pine Shoot Beetle

Mined shoots on a Scotch pine

Photograph courtesy of USDA Forest Service (1993)

The pine shoot beetle (*Tomicus piniperda L.*), a native of Europe, is an introduced pest of *Pinus* (pine) in the United States. It was first discovered in the United States at a Christmas tree farm near Cleveland, Ohio in 1992. Following the first detection in Ohio, the beetle has been detected in parts of 19 states (Connecticut, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin).

The beetle attacks new shoots of pine trees, stunting the growth of the trees. The pine shoot beetle may also attack stressed pine trees by breeding under the bark at the base of the trees. The beetles can cause severe decline in the health of the trees and, in some cases, kill the trees when high populations exist.

Adult pine shoot beetles range from 3 to 5 millimeters long, or about the size of a match head. They are brown or black and cylindrical. The legless larvae are about 5 millimeters long with a white body and brown head. Egg galleries are 10–25 centimeters long. From April to June, larvae feed and mature under the pine bark in separate feeding galleries that are 4–9 centimeters long. When mature, the larvae stop feeding, pupate, and then emerge as adults. From July through October, adults tunnel out through the bark and fly to new or 1-year-old pine shoots to begin maturation feeding. The beetles enter the shoot 15 centimeters or less from the shoot tip and move upwards by hollowing out the center of the shoot for a distance of 2.5–10 centimeters. Affected shoots droop, turn yellow, and eventually fall off during the summer and fall.

P. sylvestris (Scots pine) is preferred, but other pine species, including *P. banksiana* (jack pine), *P. nigra* (Austrian pine), *P. resinosa* (red pine), and *P. strobus* (eastern white pine), have been infested in the Great Lakes region.

Sirex Woodwasp

Close-up of female Sirex Woodwasp

Photograph courtesy of USDA (2005)

Sirex woodwasp (*Sirex noctillio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood-packing materials. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. Awareness of the symptoms and signs of a sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.

Woodwasps (or horntails) are large robust insects, usually 1.0 to 1.5 inches long. Adults have a spear-shaped plate (cornus) at the tail end; in addition, females have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America.

Sirex woodwasps can attack living pines, while native woodwasps attack only dead and dying trees. At low populations, sirex woodwasp selects suppressed, stressed, and injured trees for egg laying. Foliage of infested trees initially wilts, and then changes color from dark green to light green, to yellow, and finally to red, during the three to six months following attack. Infested trees may have resin beads or dribbles at the egg laying sites, but this is more common at the mid-bole level. Larval galleries are tightly packed with very fine sawdust. As adults emerge, they chew round exit holes that vary from 1/8 to 3/8 inch in diameter.

Spotted Lanternfly

Profile of spotted lanternfly adult at rest.

Photograph courtesy of Pennsylvania Department of Agriculture

The spotted lanternfly (SLF, *Lycorma delicatula*) is native to China and was first detected in Pennsylvania in September 2014. Spotted lanternfly feeds on a wide range of fruit, ornamental and woody trees, with tree-of-heaven (*Ailanthus altissima)* being one of the preferred hosts. Spotted lanternflies are invasive and can be spread long distances through movement of infested material or items containing egg masses. If allowed to spread in the United States, this pest could seriously impact the country's grape, orchard, and logging industries.

Adult spotted lanternflies are approximately one inch long and one-half inch wide, and they have large and visually striking wings. Their forewings are light brown with black spots at the front and a speckled band at the rear. Their hind wings are scarlet with black spots at the front and white and black bars at the rear. Their abdomen is yellow with black bars. Nymphs in their early stages of development appear black with white spots and turn to a red phase before becoming adults. Egg masses are yellowish-brown in color, covered with a gray, waxy coating prior to hatching.

The spotted lanternfly lays its eggs on smooth host plant surfaces and on non-host material, such as bricks, stones, and dead plants. Eggs hatch in the spring and early summer, and nymphs begin feeding on a wide range of host plants by sucking sap from young stems and leaves. Adults appear in late July and tend to focus their feeding on tree-of-heaven (*A. altissima*) and grapevine (*Vitis vinifera*). As the adults feed, they excrete sticky, sugar-rich fluid called honeydew. The fluid can build up on plants and on the ground underneath infested plants, causing the formation of sooty mold.

Sudden Oak Death

Drooping tanoak shoot

Photograph courtesy of Indiana Department of Natural Resources (2012)

The causal agent of sudden oak death (SOD, also known as *Phytophthora* canker disease), *Phytophthora ramorum*, was first identified in 1993 in Germany and the Netherlands on ornamental rhododendrons. In 2000, the disease was found in California. Since its discovery in North America, SOD has been confirmed in forests in California and Oregon and in nurseries in British Columbia, California, Oregon, and Washington. SOD has been potentially introduced into other states through exposed nursery stock. Through ongoing surveys, APHIS continues to define the extent of the pathogen's distribution in the United States and limit its artificial spread beyond infected areas through quarantine and a public education program.

Identification and symptoms of SOD may include large cankers on the trunk or main stem accompanied by browning of leaves. Tree death may occur within several months to several years after initial infection. Infected trees may also be infested with ambrosia beetles (*Monarthrum dentiger* and *M. scutellarer*), bark beetles (*Pseudopityophthorus pubipennis*), and sapwood rotting fungus (*Hypoxylon thouarsianum*). These organisms may contribute to the death of the tree. Infection on foliar hosts is indicated by dark grey to brown lesions with indistinct edges. These lesions can occur anywhere on the leaf blade, in vascular tissue, or on the petiole. Petiole lesions are often accompanied by stem lesions. Some hosts with leaf lesions defoliate and eventually show twig dieback.

This pathogen is devastating to *Quercus* (oaks) but also affects several other plant species.

Thousand Cankers Disease

A complex disease referred to as Thousand Cankers disease (TCD) was first observed in Colorado in 2008 and is now thought to have existed in Colorado as early as 2003. TCD is considered to be native to the United States and is attributed to numerous cankers developing in association with insect galleries.

Walnut twig beetle, side view

Photograph courtesy of USDA Forest Service (2011b)

TCD results from the combined activity of the *Geosmithia morbida* fungus and the walnut twig beetle (WTB, *Pityophthorus juglandis*). The WTB has expanded both its geographical and host range over the past two decades, and coupled with the *Geosmithia morbida* fungus, *Juglans* (walnut) mortality has manifested in Arizona, California, Colorado, Idaho, New Mexico, Oregon, Utah, and Washington. In July 2010, TCD was reported in Knoxville, Tennessee. The infestation is believed to be at least 10 years old and was previously attributed to drought stress. This is the first report east of the 100th meridian, raising concerns that large native populations of *J. nigra* (black walnut) in the eastern United States may suffer severe decline and mortality.

The tree species preferred as hosts for TCD are walnuts.

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