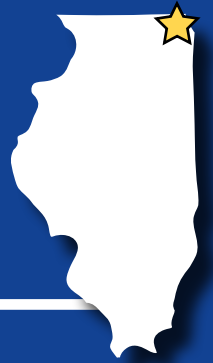




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Chicago's Urban Forest, 2019



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Abstract

A 2019 analysis of the urban forest in Chicago, Illinois, reveals that this area has an estimated 4.7 million live trees across all ownerships. The most common tree species by number are common buckthorn, white mulberry, and Siberian elm. Trees in Chicago are estimated to store about 754,787 tons of carbon (2.8 million tons of carbon dioxide [CO₂]) valued at \$128.7 million. In addition, it is estimated that these trees annually remove about 77,000 tons of CO₂ and 774 tons of air pollution. Chicago's urban forest is estimated to reduce annual energy costs of residential buildings by \$1.8 million. The overall compensatory value of the urban forest is estimated at \$2.3 billion. Compensatory value describes the replacement value of trees as a structural asset, which tends to increase with trees' size and health. The information presented in this report can be used to support urban forest management programs and to inform policy and planning to improve environmental quality and human health in Chicago. The analysis also provides a basis for monitoring changes in the urban forest over time.

Keywords: Urban FIA, UFIA, i-Tree, iTree, Illinois, IL, My City's Trees, carbon, city, cities, tree volume and biomass, carbon sequestration, Urban Forest Inventory and Analysis, urban forest structure and health, urban forest values, ecosystem services

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Cover photo: Overlooking Grant Park from a Chicago skyscraper as pedestrians enjoy the Lollapalooza music festival below. Courtesy photo by Paul Bazan, Chicago, IL.

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Chicago's Urban Forest, 2019

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EXECUTIVE SUMMARY



Trees provide cooling shade and relaxing spaces for people recreating in Milton Lee Olive Park, Chicago. USDA Forest Service photo by Thomas Brandeis.

The City of Chicago was sampled from 2016 through 2019 to complete the initial Urban Forest Inventory and Analysis assessment, establishing a baseline of the magnitude, composition, and value of its urban forest resource. The sampled area of the city (representing a total of 149,835 acres), is estimated to contain 4.7 million live trees, 68.9 percent of which are less than 5.0 inches in **diameter**¹. The most common tree species² at least one inch in diameter are common buckthorn, white mulberry, Siberian elm, boxelder, and Norway maple. The most common large-diameter tree species (11.0 inches or greater in diameter) are silver maple, Norway maple, eastern cottonwood, honeylocust, and white mulberry. The most dominant species based on the number of trees and leaf area are common buckthorn, silver maple, Norway maple, white mulberry, and eastern cottonwood.

¹ See glossary for definition of bolded terms.

² Common and scientific names for all tree species observed in the Urban FIA inventory of Chicago are reported in Appendix 2.



The majority of trees are found on **forest land** (49.2 percent; 2.3 million trees). Overall, 32.3 percent of trees are classified as growing in maintained areas. Trees on public lands total 3.5 million and account for 75.1 percent of the total live tree population. Trees on private lands total 1.2 million and account for 24.9 percent of the population.

Urban forest ecosystem services were evaluated in terms of air pollution removal, carbon sequestration, reduction in stormwater runoff, and effects on residential building energy use and carbon emissions. The compensatory value of the urban forest (roughly equivalent to the replacement value of all trees in the urban forest) is estimated at \$2.3 billion with the urban forest producing over \$37 million in annual benefits (Table 1).

The tree species with the greatest estimated average percent dieback is green ash (21.7 percent dieback) and the species with the greatest rot is Norway maple (3.4 percent rot). The most common urban damages affecting all tree species in the sampling area are conflict with crown (10.1 percent of trees) and topping/pruning (7.2 percent of trees). Tree species with the greatest proportion of their population affected by urban damages are Siberian elm (38.9 percent of trees affected by conflict with crown) and white mulberry (34.0 percent of trees affected by topping/pruning).

Invasive species also threaten to alter forest composition and were found on 54.6 percent of the sampled plots; Norway maple is estimated to cover the largest area (5,342 acres) of any invasive plant species in the city.

These natural and anthropogenic threats may affect the health and composition of Chicago's urban forest. Through better understanding of the benefits conferred by and potential threats to the urban forest, resource managers, arborists, and city planners can improve forest management, leading to healthier urban forests and more livable communities.

Table 1.– Summary of the urban forest estimates, Chicago 2019

Feature	Estimate
Number of trees ^a	
Total live trees	4.7 million (1.7 million) ^b
Live saplings (1 to 4.9 inches in diameter)	3.2 million (1.5 million) ^b
Live trees (at least 5.0 inches in diameter)	1.5 million (216,667) ^b
Standing dead saplings (1 to 4.9 inches in diameter)	197,000 (113,000) ^b
Standing dead trees (at least 5.0 inches in diameter)	89,000 (42,000) ^b
Most abundant species by	
Number of live trees	common buckthorn
Leaf area	silver maple
Ecosystem impacts and services	
Pollution removal	774 tons/year (\$27.6 million/year)
Reduction in acute respiratory symptoms	2,791 cases/year (\$243,000/year)
VOC emissions	506 tons/year
Avoided runoff	62.2 million cubic feet (\$4.2 million/year)
Carbon storage ^c	755,000 tons (\$128.7 million)
Carbon sequestration ^c	21,000 tons/year (\$3.6 million/year)
Net aboveground volume	52.4 million cubic feet
Reduced building energy use ^{c,d}	-95,000 GJ/year (\$1.8 million/year)
Reduced carbon emissions ^{c,d}	-1,000 tons/year (\$-175,000/year)
Compensatory value	\$2.3 billion

Due to rounding, not all values will add up exactly.

VOC = volatile organic compound.

Ton = short ton (U.S.) (2,000 lbs.).

To convert carbon estimates to carbon dioxide, multiply carbon value by 3.667.

GJ = gigajoule (one billion [10⁹] joules).

^a Diameter measurements were taken at breast height (d.b.h) or root collar (d.r.c.) for woodland species (see glossary for definition).

^b Numbers in parentheses are standard error.

^c Estimates are for the live and dead tree population. All other estimates are based on the live tree population only, except where noted.

^d Estimates are calculated using trees greater than or equal to 5 inches in diameter.

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BACKGROUND



Trees, shrubs, and other vegetation reduce surface runoff by capturing rainfall on leaves and absorbing water from the soil. In Chicago, the leaves of trees reduce runoff by about 465 million gallons of water per year. USDA Forest Service photo by Thomas Brandeis.

Urban forests offer a wide range of environmental, social, and public health benefits, such as wildlife habitat, aesthetic appeal, social cohesion, enhanced recreational opportunities, reduced air temperatures, improved water quality, mitigated air and noise pollution, and benefits to mental health and well-being. Since 1930, the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis (FIA) program has provided information on the amount, status, and character of **forest land**³ across the country. The 2014 U.S. Farm Bill (Agricultural Act of 2014) directed FIA to explore possibilities to expand the scope of the FIA inventory to include forest monitoring in U.S. urban areas. This effort led to the development of the current FIA Strategic Plan (U.S. Forest Service 2016a) that includes a special focus on the nation's most populous cities.

³ See glossary for definition of bolded terms.



In this report, the term “urban forest” describes all trees found in the city across both public and private ownerships, including planted trees along streets and boulevards, trees in parks and residential yards, remnant forest along railroads and riparian areas, small woodlots, and larger **forested areas**. FIA has partnered with the Forest Service i-Tree team, which has a long tradition of conducting urban forest inventories and delivering data about urban forests and their associated ecosystem services. This combined national urban forest inventory effort leverages the strengths of both groups, drawing on the urban data processing and reporting capacities of the i-Tree program and FIA’s quality, consistency, and comprehensiveness of data collection.

Urban FIA data were collected in Chicago from 2016–2019 on research plots spread across public and private land with varied land uses. Upon completion, Chicago became one of the first 10 cities with a full set of Urban FIA data, with many cities from across the nation to follow. Urban FIA is designed to assess change over time and this first inventory cycle of data will serve as a baseline against which future Urban FIA data can be compared.

In 2014, the Chicago Region Trees Initiative (CRTI) was initiated by The Morton Arboretum and Openlands organization, with the vision of making Chicago the “greenest, most livable, most resilient region in North America.” (CRTI 2022)

The CRTI has defined the following four overarching goals:

- Inspire people to value trees
- Increase the Chicago region’s tree canopy
- Reduce threats to trees
- Enhance oak ecosystems

Close partnership between The Morton Arboretum, Urban FIA, and i-Tree will allow the Urban FIA data to strongly support each of the four goals of the CRTI. Providing information about Chicago's urban forest and the many benefits it offers may help inspire people to value trees, to learn more, to act as stewards and to educate others. Tracking the progress of the second, third, and fourth goals of the CRTI is critical to understanding the success of the initiative and will require continued study and mapping of the urban forest resources. Urban FIA is uniquely situated to track such changes within the city limits, and to provide information about changes in tree population dynamics, potential pest and diseases that could threaten trees, and additional data which could guide the enhancement of oak and other urban forest ecosystems.

Monitoring and understanding urban forest resources is also a critical piece of tracking the success of many goals laid out in the Chicago Metropolitan Agency for Planning's (CMAP) ON TO 2050 document, which states that "Integrating green infrastructure into the redevelopment process can result in additional parks and open spaces, tree-lined streets, and stormwater management. Combined, these investments provide places for recreation, habitats for native flora and fauna, air pollutant filtration, flood reduction, urban heat island mitigation, and groundwater recharge, while at the same time creating more desirable, healthy, and resilient communities" (CMAP 2022). CMAP's plan to "expand urban forestry efforts to protect existing trees and to increase and diversify the tree canopy" and to "incorporate site-scale green infrastructure, trees, landscaping, etc. into non-park spaces, including street rights of way, parking lots, and private property" can be guided and evaluated using Urban FIA data (CMAP 2022).

METHODS

To evaluate the extent, composition, and benefits of Chicago's urban forest and establish a baseline for future monitoring, a sample-based inventory was conducted following Urban FIA monitoring methods and reporting tools described in the Urban FIA Field Guide Version 7.1 (USDA Forest Service 2017) and the online supplement (Baer et al. 2024) to this report, along with i-Tree Eco modeling software (www.itreetools.org; Nowak 2020). This process established survey plots across Chicago and aims to revisit those plots every 7 years. Future reports can build on these data and consistently provide information on urban forest extent, diversity, health condition, and benefits. During the 2019 field season, Chicago's 7-year measurement cycle was accelerated to complete the sample in a 4-year period. The sampling area was defined by the U.S. Census Bureau Designated Places boundary for Chicago (highlighted in red in Fig. 1a). In total, the urban FIA sample surveyed 183 plots across the city's 149,835 acres within the designated sampling area in Chicago (Fig. 1).

New methods were implemented in the inventory of Chicago's urban forest to allow for flexibility in the estimation of tree characteristics for forked trees. In this inventory, all stems of forked trees are quantified and characterized as part of the same tree. All extrapolated estimates for forked trees are based on this approach except for estimates of tree merchantability and volume estimation. Refer to Baer et al. (2024) for more detailed information. Throughout this report, except where explicitly noted, trees refer to woody plant species listed in Appendix 3 and 3B of the Northern Research Station (NRS) Urban Field Guide Version 7.1 (USDA Forest Service 2017) with **diameters** of at least 1.0 inch, and results are given for live trees.

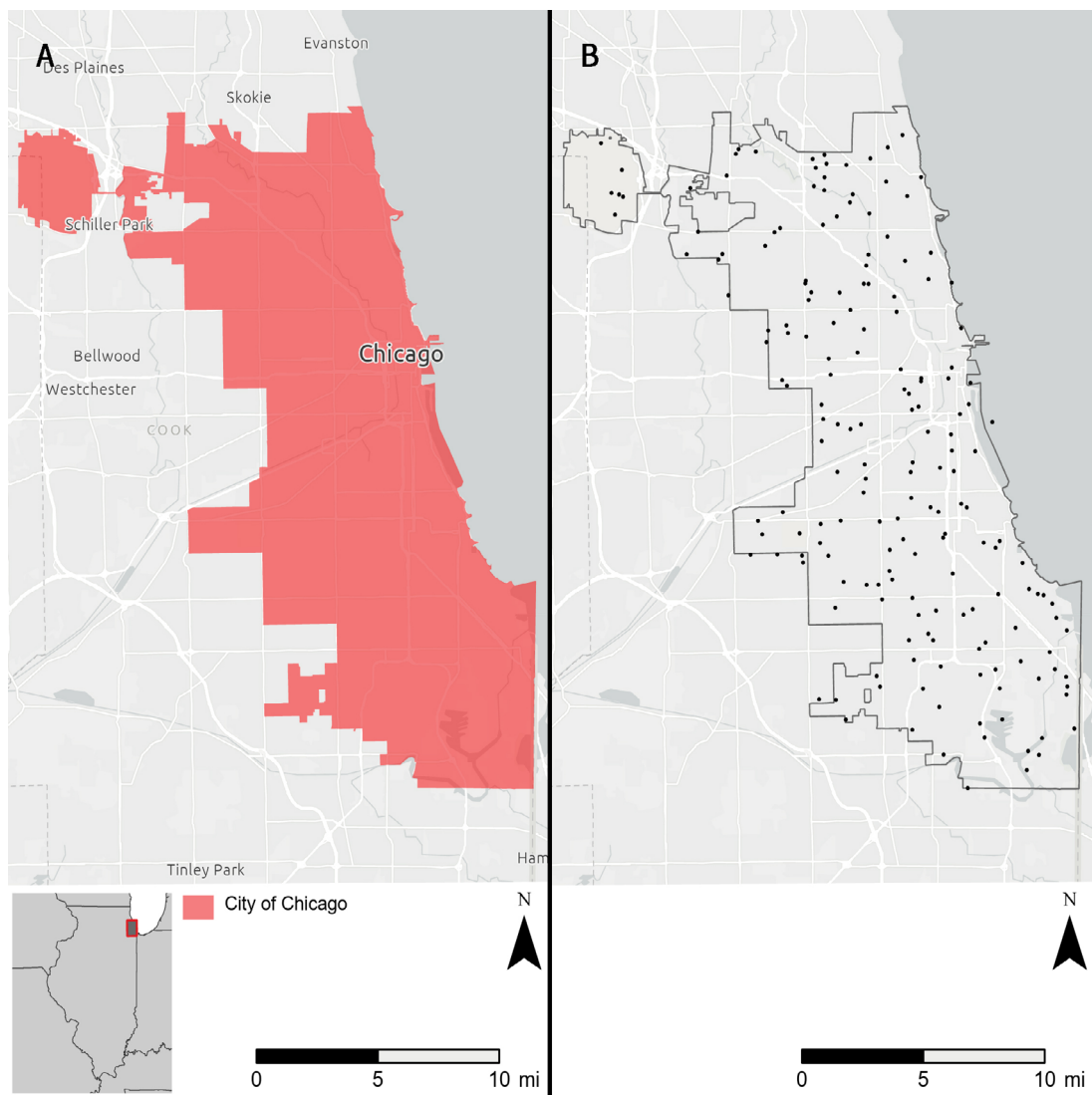


Figure 1.—Study area (a) and approximate plot locations (b) for the Urban FIA inventory of Chicago, 2019.

The collected data were analyzed using FIA methodology and i-Tree Eco modeling software outlined in Baer et al. (2024). Additional analyses were conducted using R Statistical software version 4.2.1 (R Core Development Team 2022) and Tableau Desktop 2020.1 (Copyright © 2003–2023 Tableau Software, LLC, A Salesforce Company. All rights reserved.); figures presented in this report were generated using the base, dplyr (Wickham et al. 2022), and ggplot2 (Wickham 2016) packages within the R Statistical Software platform, and Microsoft Excel. Maps throughout this document were created using ArcGIS® software by Esri (Esri 2021a, b). ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license.

This report summarizes the findings of these analyses and includes information on the urban forest structure, ecosystem services, and associated monetary values. Structure describes various physical attributes of the urban forest, including tree species composition, number of trees, tree density, tree health, leaf area, biomass, and species diversity. Ecosystem services discussed in this report were evaluated based on urban forest structure in conjunction with local environmental variables and include such attributes as air pollution removal and carbon storage and sequestration. Monetary values are an economic estimate of various ecosystem services or structural attributes.

In addition to this report, information from this analysis is accessible via [My City's Trees](#) and [Urban Forest Stats](#), online interactive tools that allow users to explore results and print data queries. Data tables are also available for download from FIA's [Urban DataMart](#).

AREA AND COVER CHARACTERISTICS



Looking across vegetated land cover towards the city of Chicago. Along with numerous tree measurements, Urban FIA data collectors record how the land is utilized and what kind of surface and vegetation cover is present. USDA Forest Service Photo by Thomas J. Brandeis.

In 2010, Illinois had 2,526,000 acres of urban land that covered 7.1 percent of the state area, and this urban area is projected to increase to 14.8 percent by the year 2060 (Nowak and Greenfield 2018). Chicago is the largest city in Illinois by population (2,696,000 residents with a population density of 11,842 per square mile in 2010).



Land Cover

National land cover data were used to analyze the variability of the urban forest across the city by land cover class (Homer et al. 2015; MRLC 2018). Plots were categorized into general land cover classes (Table 2).

Land cover definitions are based on the 2011 National Land Cover Database (NLCD) (Homer et. al. 2015) and are described in Appendix 1. The most prevalent land cover classification is developed-medium, followed by developed-high, developed-low & vegetated, and water (Table 3). Figure 2 shows the distribution of landcover classes across the city. Areas of developed-low & vegetated land cover are estimated to contain the greatest proportion of trees in the sampling area of any land cover (60.7 percent), followed by developed-medium, and developed-high land covers (25.6 percent and 13.6 percent of the trees in the sampling area, respectively).

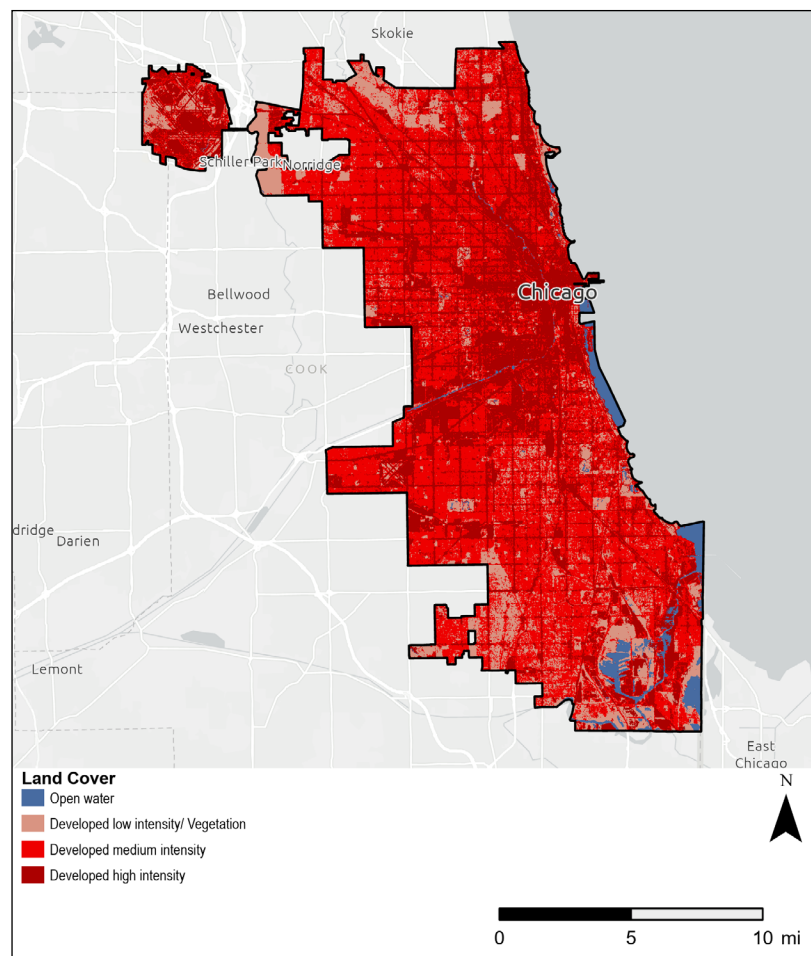


Figure 2.—Distribution of NLCD land cover classes, Chicago, 2019

Table 2.—Description of aggregated National Land Cover Database (NLCD) land cover classes, Chicago, 2019

NLCD Label	Description
Water	Open Water
Developed-low/vegetated	Developed, Low Intensity and Developed, Open Space and Woody Wetlands and Deciduous Forest and Grassland/Herbaceous and Pasture/Hay and Cultivated Crops and Emergent Herbaceous Wetlands and Shrub/Scrub and Mixed Forest and Evergreen Forest
Developed-medium	Developed, Medium Intensity
Developed-high	Developed, High Intensity and Barren Land (Rock/Sand/Clay)

Source: Homer et al. 2015

Table 3.—Sample area and count of plots within National Land Cover Database (NLCD) land cover classes in Chicago, 2019

Land cover	Area (acres)	City land area (percent)	Plots (number)
Developed-medium	64,450	43	87
Developed-high	43,817	29	51
Developed-low/vegetated	37,101	25	41
Water	4,467	3	4
Total	149,835	100	183

Due to rounding, not all values will add up exactly.

FIA Land Use

In addition to categorization according to NLCD land cover classes, plots were also classified in the field based on FIA land use classes (Table 4). These categories provide a specific look at how the land is being used by the local population in Chicago.

Rights-of-way is the most prevalent land use class in Chicago, covering 29.5 percent of the city area (containing 15.2 percent of the city's trees), followed by single-family residential (hereafter, residential) (27 percent of the city area), commercial/industrial (26.4 percent), multi-family residential (5.9 percent), and recreation/cemetery (5.3 percent)(Table 5).

Table 4.—Description of Forest Inventory and Analysis (FIA) land use classes and subclasses, Chicago, 2019

FIA land use	FIA land use subtypes
Agriculture	Agriculture, Christmas tree plantation, cropland, idle farmland, maintained wildlife openings, nursery, orchard, pasture, shelterbelt, windbreak
Commercial/Industrial	Commercial, cultural, developed, industrial, institutional, mining, wasteland
Forest	None
Multi-family residential	None
Natural lands	Beach, nonvegetated land, other, wetland
Rangeland/Chapparral	None
Recreation/Cemetery	Cemetery, golf course, park, recreation
Residential	None
Right-of-way	Right-of-way, transportation, utility
Water	None

Source: National Urban FIA field guide Version 7.1 (USDA Forest Service 2017)

Table 5.— Sample area and plot counts within Forest Inventory and Analysis (FIA) land use classes, Chicago, 2019

FIA land use	Area (acres)	Standard error (acres)	City land (percent)	Plots (number)
Forest land	2,343	1,337	1.6	2.8
Agriculture	1,132	938	0.8	1.3
Commercial/Industrial	39,614	4,259	26.4	48.4
Multi-family residential	8,823	2,372	5.9	11.3
Residential	40,448	3,716	27.0	50.2
Recreation/Cemetery	7,874	2,269	5.3	8.9
Rights-of-way	44,208	4,079	29.5	54.9
Water	5,393	914	3.6	5.3
Total	149,835	1,623	100.0	183.0

Due to rounding, not all values will add up exactly.

Tree, Shrub, and Ground Cover

Tree cover in Chicago is estimated at 16.1 percent and shrub cover is estimated at 2.4 percent based on field crew assessments. Field plot estimates are used to evaluate tree cover and can have a relatively high degree of uncertainty due to the nature of tree cover data collection in the field and effects of sample size. Generally, better tree cover estimates can be derived from photointerpretation or high-resolution tree cover maps.

Overall, tree cover ranges from 0.05 percent to 90 percent on plots where trees are present (Fig. 3a). Shrub cover ranges from 1.99 percent to 57.45 percent on plots where shrubs are present (Fig. 3b). Average tree cover is highest on forest land (91.4 percent tree cover), rights-of-way (26.4 percent), and recreation/cemetery lands (19.2 percent; Table 6). Shrub cover is highest on forest land (33.7 percent shrub cover), residential (3.8 percent), and multi-family residential (2.6 percent). Impervious cover is highest on rights-of-way (63.7 percent impervious cover), commercial/industrial (37.1 percent), and multi-family residential (31.8 percent) (Table 6).

Table 6.—Average percent tree, shrub, and impervious cover by Forest Inventory and Analysis (FIA) land use class, Chicago, 2019

FIA land use	Tree (percent)	Shrub (percent)	Impervious (percent)
Forest land	91.4	33.7	0.4
Agriculture	9.7	0.1	1.7
Commercial/Industrial	5.5	1.9	37.1
Multi-family residential	11.1	2.6	31.8
Residential	13.9	3.8	20.7
Recreation/Cemetery	19.2	1.7	19.2
Rights-of-way	26.4	0.3	63.7
Water	0.0	0.0	0.0
Total average	16.1	2.4	37.1
Total standard error	1.6	0.5	2.2

Due to rounding, not all values will add up exactly.

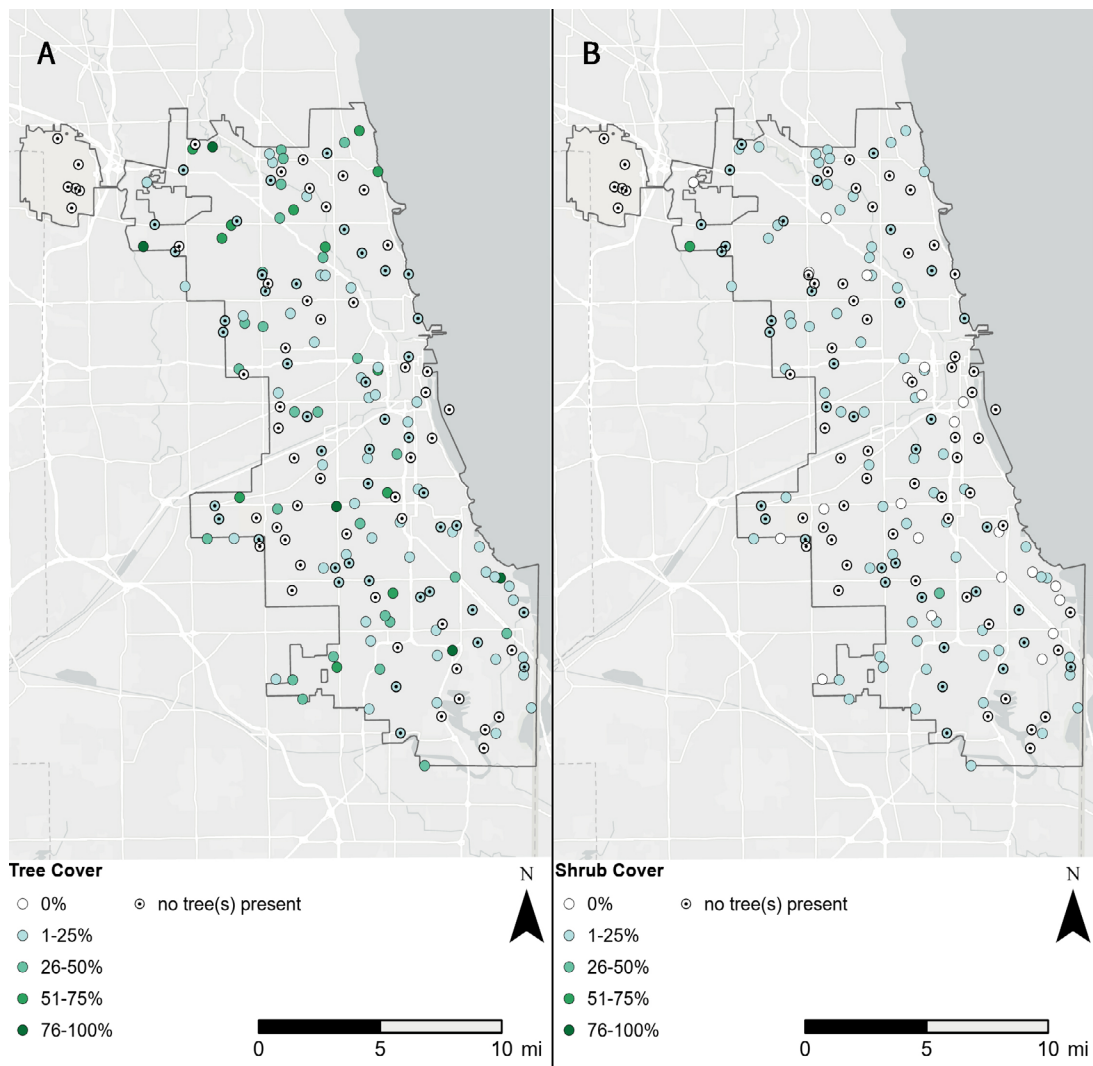


Figure 3.—Tree (A) and shrub (B) cover estimates by plot, Chicago, 2019. Plot locations are approximate.

Field crews categorized ground surface cover on each field plot according to five classes: (i) building, (ii) low vegetation, (iii) permeable (soil, leaf litter, mulch, gravel, etc.), (iv) impervious (non-building), or (v) water. Permeable and herbaceous ground covers account for 35.2 percent of all ground covers, while building and other impervious cover account for 61.2 percent. An additional 3.6 percent of the city is classified as water (Figs. 4 and 5). Please note that percentages may not add up to 100 percent due to rounding.

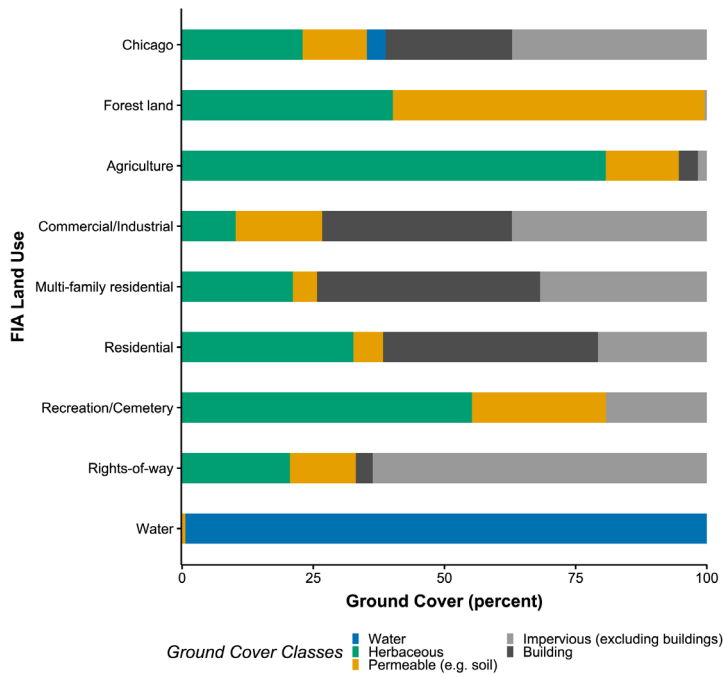
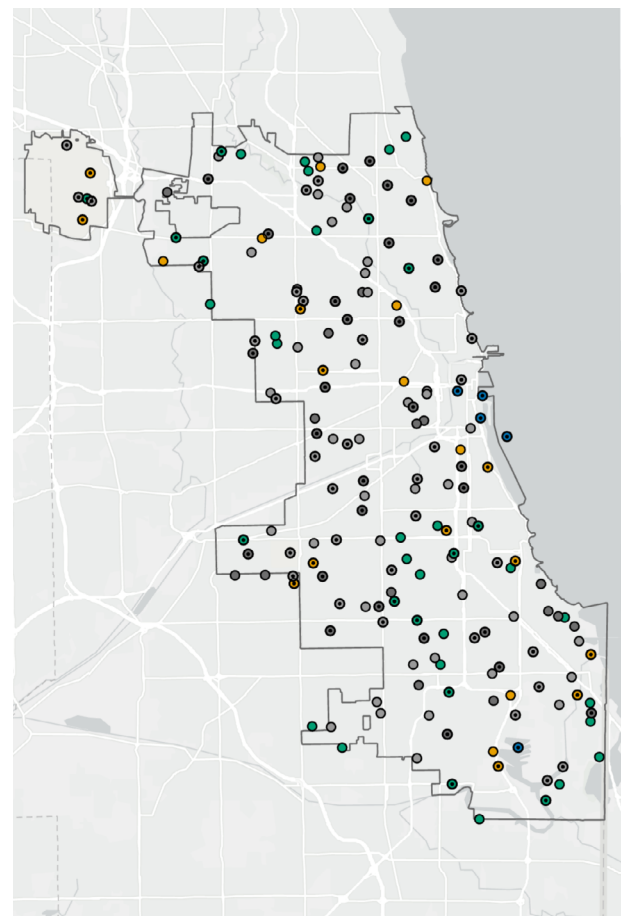


Figure 4.—Ground cover distribution by Forest Inventory and Analysis (FIA) land use class, Chicago, 2019.



Dominant Ground Cover

- Building
- Impervious (non-building)
- Herbaceous
- Permeable (non-herbaceous)
- Water
- no tree(s) present

0 5 10 mi

Figure 5.—Dominant ground cover by plot, Chicago, 2019. Plot locations are approximate.

Ownership

Plot ownership was divided into private, State and local government, Federal government, and unknown (water) classes. The most dominant ownership in Chicago is private (59.8 percent), followed by State and local (36.6 percent), and unknown (water) (3.6 percent) (Table 7). Percent tree cover is greatest in State and local (28.6 percent), followed by private (9.5 percent), and unknown (water) (0 percent). In Chicago, there are approximately 4 million trees (75.1 percent of the live tree population) on State and local lands, and 1 million trees (24.9 percent) on private land (Table 7). Chicago's sapling population is mostly found on State and local lands (75.9 percent), followed by private lands (24.1 percent) (Table 7).

Table 7.—Distribution of percent of live trees within diameter classes by ownership, Chicago, 2019

Ownership class	1-4.9 in. diameter trees (percent)	5-10.9 in. diameter trees (percent)	11+ in. diameter trees (percent)	Total (percent)	Area (percent)
State and Local	75.9	74.8	72.2	75.1	36.6
Private	24.1	25.2	27.8	24.9	59.8
Unknown (water)	0.0	0.0	0.0	0.0	3.6
Total	100.0	100.0	100.0	100.0	100.0

Due to rounding, not all values will add up exactly.

FOREST STRUCTURE



Urban forests often consist of a wide range of native and non-native tree species, many of which have been planted in maintained areas such as yards and along city streets. USDA Forest Service photo by Sjana Schanning.

Number of Trees

Chicago's urban forest has an estimated 4.68 million live trees and 286,000 standing dead trees. The number of trees varies by land use and diameter class. Nearly half of the trees in Chicago are located on forest land (49.2 percent, 2.3 million trees)(Table 8). Overall, 68.9 percent of Chicago's trees are saplings (1.0–4.9 inches in diameter), while the remaining 12.9 percent and 18.3 percent are medium trees (5.0–10.9 inches in diameter) and large trees (≥ 11.0 inches in diameter), respectively.

The greatest proportion and highest density of trees (60.7 percent, 77 trees per acre) are found within the developed-low & vegetated land cover class (Table 9).

Table 8.—Distribution of live trees by Forest Inventory and Analysis (FIA) land use class and diameter class, Chicago, 2019

FIA land use	1-4.9 in. diameter trees (number)	5-10.9 in. diameter trees (number)	11+ in. diameter trees (number)	Total (number)	SE (number)	Density (no./ac.)
Forest land	1,970,000	209,000	125,000	2,300,000	1,570,000	982
Agriculture	0	0	5,800	5,800	5,600	5
Commercial/Industrial	396,000	69,000	55,000	520,000	401,000	13
Multi-family residential	0	35,000	20,000	55,000	29,000	6
Residential	382,000	71,000	170,000	623,000	274,000	15
Recreation/Cemetery	358,000	54,000	49,000	461,000	378,000	59
Rights-of-way	119,000	164,000	430,000	713,000	145,000	16
Water	0	0	0	0	0	0
Total	3,220,000	602,000	855,000	4,680,000	–	31
Total standard error	1,520,000	144,000	102,000	1,670,000	–	–

Due to rounding, not all values will add up exactly.

– = no value for cell

Table 9.—Distribution of live trees by National Land Cover Database (NLCD) land cover class and diameter class, Chicago, 2019

Land cover	1-4.9 in. diameter trees (number)	5-10.9 in. diameter trees (number)	11+ in. diameter trees (number)	Total (number)	Total SE (number)	Density (no./ac)
Water	0	0	0	0	0	0
Developed-low/vegetated	2,290,000	245,000	309,000	2,840,000	1,580,000	77
Developed-medium	537,000	232,000	431,000	1,200,000	355,000	19
Developed-high	396,000	126,000	115,000	637,000	400,000	15
Total	3,220,000	602,000	855,000	4,680,000	–	31
Total standard error	1,520,000	144,000	102,000	1,670,000	–	–

Due to rounding, not all values will add up exactly.

– = no value for cell

Species Composition

The 10 most common tree species⁴ by number account for 86.3 percent of all recorded live trees and are common buckthorn, white mulberry, Siberian elm, boxelder, Norway maple, silver maple, peach, eastern cottonwood, hackberry, and honeylocust (Table 10; Fig. 6). A breakdown of the estimated number of each recorded tree species by diameter classes is presented in Appendix 2. Small diameter trees (saplings) are generally the most abundant of the three tree size classes for the 10 most common tree species, and are 78.3 percent of the total number of trees, while large diameter trees make up only 14.4 percent of the total number of trees (Table 11, Fig. 7). When broken down into 2-inch diameter classes, the four most common species by number (common buckthorn, white mulberry, Siberian elm and boxelder) show an abundance distribution skewed toward smaller diameter trees. In contrast, the majority (61.6 percent) of Norway maple which is the fifth most common species by number, are in the 11-inch diameter and greater category (Fig. 8).

Table 10.—Urban forest species composition in Chicago, 2019

Common name	Trees (number)	Percent
ailanthus	53,000	1.1
American basswood	41,000	0.9
American elm	75,000	1.6
apple spp.	4,700	0.1
baldcypress	4,700	0.1
black cherry	58,000	1.2
black oak	41,000	0.9
black walnut	15,000	0.3
boxelder	257,000	5.5
bur oak	12,000	0.2
Callery pear	9,500	0.2
catalpa spp.	4,700	0.1
Chinese elm	4,700	0.1
common buckthorn	1,940,000	41.5
dogwood spp.	4,700	0.1
eastern cottonwood	114,000	2.4
eastern redbud	26,000	0.6

continued on next page

Table 10 (continued).

Common name	Trees (number)	Percent
eastern redcedar	5,800	0.1
eastern white pine	15,000	0.3
Freeman maple	21,000	0.5
ginkgo, maidenhair tree	4,700	0.1
green ash	70,000	1.5
hackberry	102,000	2.2
honeylocust	102,000	2.2
littleleaf linden	34,000	0.7
London planetree	11,000	0.2
northern catalpa	14,000	0.3
northern red oak	17,000	0.4
Norway maple	232,000	5.0
Norway spruce	14,000	0.3
peach	149,000	3.2
pin oak	5,800	0.1
red maple	9,500	0.2
red mulberry	5,800	0.1
red spruce	4,700	0.1
Russian-olive	4,700	0.1
shagbark hickory	5,800	0.1
Siberian elm	307,000	6.6
silver maple	223,000	4.8
slippery elm	11,000	0.2
Turkish hazelnut	5,200	0.1
western redcedar	4,700	0.1
white ash	16,000	0.4
white mulberry	612,000	13.1
Yoshino flowering cherry	4,700	0.1
Total	4,680,000	100.0

Due to rounding, not all values will add up exactly.

For a breakdown of species composition by diameter classes, refer to Appendix 2.

⁴ Common and scientific names for all species observed in the Urban FIA inventory of Chicago are reported in Appendix 2.

Table 11.—Live trees by size class for the ten most common tree species by number in Chicago, 2019

Species	1-4.9 in. diameter trees (number)	5-10.9 in. diameter trees (number)	11+ in. diameter trees (number)	Total (number)
common buckthorn	1,900,000	46,000	0	1,940,000
white mulberry	538,000	5,200	69,000	612,000
Siberian elm	262,000	27,000	17,000	307,000
boxelder	143,000	94,000	19,000	257,000
Norway maple	60,000	30,000	143,000	232,000
silver maple	60,000	14,000	149,000	223,000
peach	143,000	5,800	0	149,000
eastern cottonwood	0	26,000	88,000	114,000
hackberry	60,000	15,000	27,000	102,000
honeylocust	0	32,000	70,000	102,000
Total of top 10	3,160,000	294,000	583,000	4,040,000

Due to rounding, not all values will add up exactly.

Standard errors for each estimate are reported in Appendix 2.

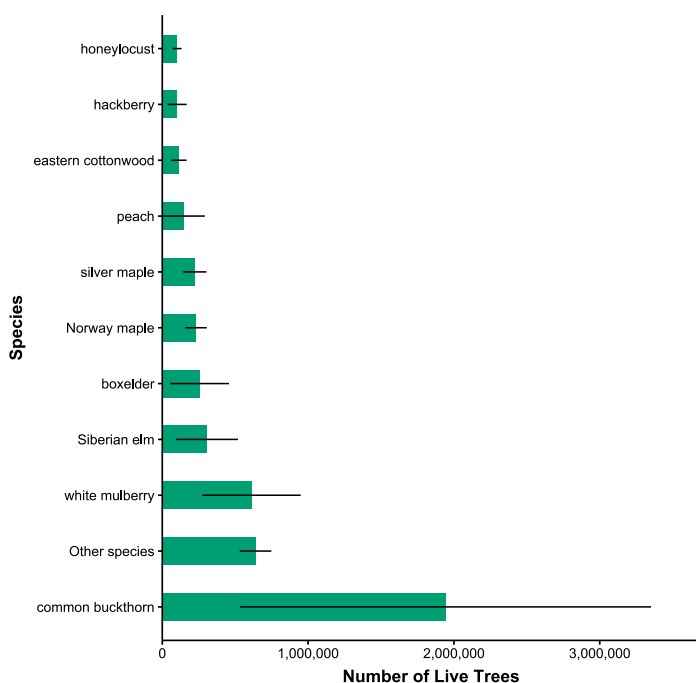


Figure 6.—The 10 most common tree species by number of trees, Chicago, 2019. Other species is the total number of all other tree species in the inventory. Error bars represent 68 percent confidence intervals around the estimated means.

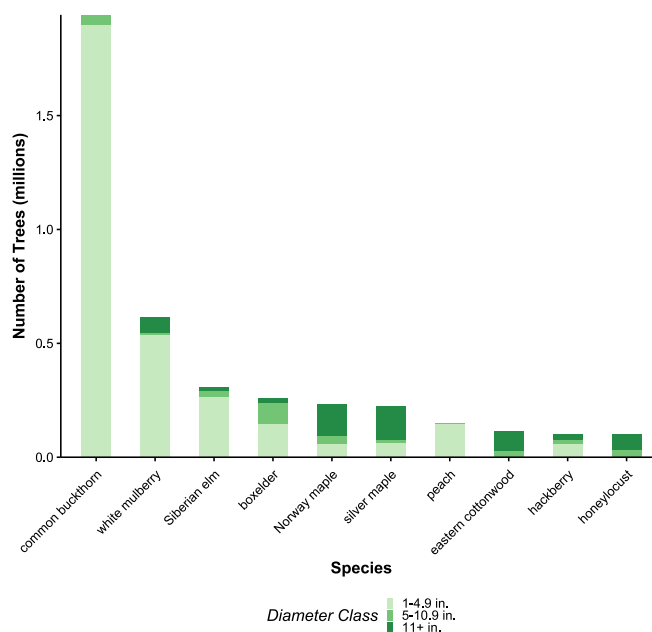


Figure 7.—Number of trees by diameter class for the 10 most common tree species, Chicago, 2019.

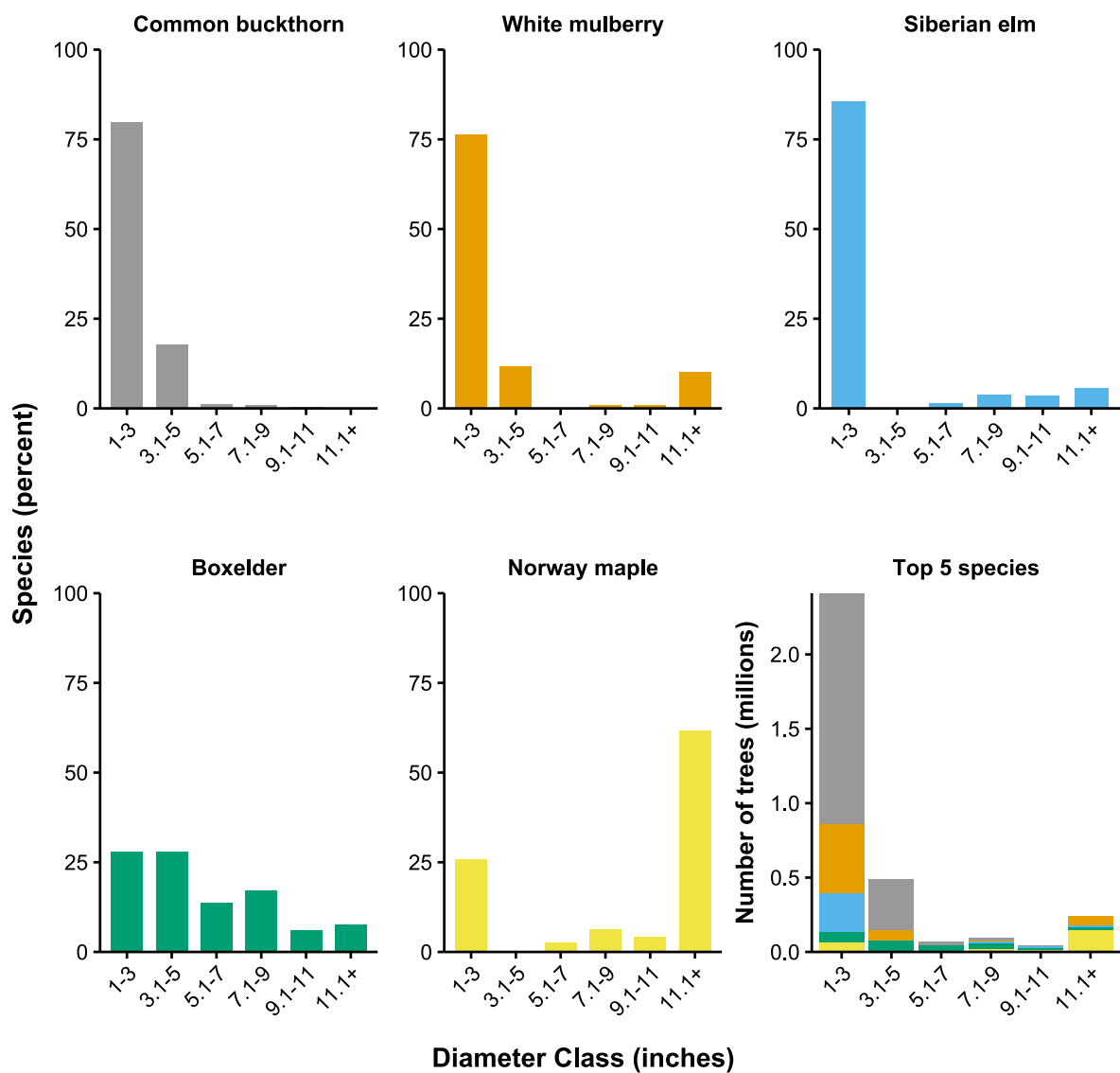


Figure 8.—Percentage of species population by diameter class for the five most common tree species by number of trees, Chicago, 2019.

The preceding table and figures highlight the most prominent species by number for all trees 1.0 inch in diameter and larger. As smaller diameter trees are generally more abundant per unit area, the overall species composition may be more reflective of the smaller diameter species when analyzing estimates based on number of trees. For this reason, it is also helpful to rank species according to other metrics such as the number of trees within various size classes, leaf area, importance value, volume, or biomass. The three most common species in terms of stem numbers in the smallest-diameter size classes (less than 5.0 inches in diameter) are common buckthorn, white mulberry, and Siberian elm, together representing more than three quarters (83.7 percent) of all live trees less than 5.0 inches in diameter (Table 12; Appendix 2). Boxelder, green ash, and common buckthorn are the most common species in intermediate diameter size classes, representing 31.3 percent of all live trees between 5.0 and 10.9 inches in diameter. Dominant species in the largest diameter classes, often the most recognizable component of the urban forest canopy, are silver maple, Norway maple, and eastern cottonwood, which constitute 44.5 percent of live trees at least 11.0 inches in diameter (Table 12; Appendix 2).

Table 12.—The five most common tree species by number of trees withing each diameter class, Chicago, 2019

Diameter class	Common name	Trees (number)
1.0–4.9 in. diameter class		
	common buckthorn	1,900,000
	white mulberry	538,000
	Siberian elm	262,000
	boxelder	143,000
	peach	143,000
5.0–10.9 in. diameter class		
	boxelder	94,000
	green ash	49,000
	common buckthorn	46,000
	black cherry	35,000
	honeylocust	32,000
11+ in. diameter class		
	silver maple	149,000
	Norway maple	143,000
	eastern cottonwood	88,000
	honeylocust	70,000
	white mulberry	69,000

Due to rounding, not all numbers will add up exactly.

In Chicago, tree species composition on private land is dominated by white mulberry (32.7 percent), peach (12.8 percent), and common buckthorn (11.3 percent) (Table 13). The most common tree species on public lands are common buckthorn (51.5 percent), white mulberry (6.5 percent), and boxelder (6.2 percent) (Table 14). A total of 27 tree species are recorded on private lands, resulting in a Shannon-Wiener diversity index value of 2.3. The 37 species of trees recorded on public lands, result in a **Shannon-Wiener diversity index** value of 2.1. The Shannon-Wiener diversity index takes into account tree species richness (total number of species) and species evenness (relative abundances among species), and ranges from approximately 2.0–3.5 within cities measured using Urban FIA protocol. On private land, the top three genera with the greatest number of trees are mulberry, plum/cherry (*Prunus* spp.), and maple (*Acer* spp.). On public land they are buckthorn (*Rhamnus* spp.), maple (*Acer* spp.), and elm (*Ulmus* spp.; Fig. 9). Species composition within NLCD land cover classes is detailed in Appendix 3.

Table 13.—Species composition on private lands in Chicago, 2019

Species	Trees (percent)	Species	Trees (percent)	Species	Trees (percent)
white mulberry	32.7	littleleaf linden	1.3	red mulberry	0.5
peach	12.8	American elm	0.9	London planetree	0.5
common buckthorn	11.3	green ash	0.9	red spruce	0.4
Siberian elm	10.6	black walnut	0.9	western redcedar	0.4
silver maple	6.4	eastern white pine	0.9	catalpa spp.	0.4
eastern cottonwood	6.4	American basswood	0.9	hackberry	0.4
boxelder	3.4	eastern redcedar	0.5	Russian-olive	0.4
Norway maple	3.2	white ash	0.5	Yoshino flowering cherry	0.4
ailanthus	2.1	honeylocust	0.5	Callery pear	0.4

Estimates are rounded.

Table 14.—Species composition on private lands in Chicago, 2019

Species	Trees (percent)	Species	Trees (percent)	Species	Trees (percent)
common buckthorn	51.5	American basswood	0.9	pin oak	0.2
white mulberry	6.5	ailanthus	0.8	Turkish hazelnut	0.1
boxelder	6.2	eastern redbud	0.7	eastern white pine	0.1
Norway maple	5.6	Freeman maple	0.6	baldcypress	0.1
Siberian elm	5.2	littleleaf linden	0.5	dogwood spp.	0.1
silver maple	4.2	northern red oak	0.5	ginkgo, maidenhair tree	0.1
hackberry	2.8	Norway spruce	0.4	black walnut	0.1
honeylocust	2.7	northern catalpa	0.4	apple spp.	0.1
American elm	1.8	bur oak	0.3	London planetree	0.1
green ash	1.7	white ash	0.3	Callery pear	0.1
black cherry	1.7	slippery elm	0.3	Chinese elm	0.1
black oak	1.2	red maple	0.3		
eastern cottonwood	1.1	shagbark hickory	0.2		

Estimates are rounded.

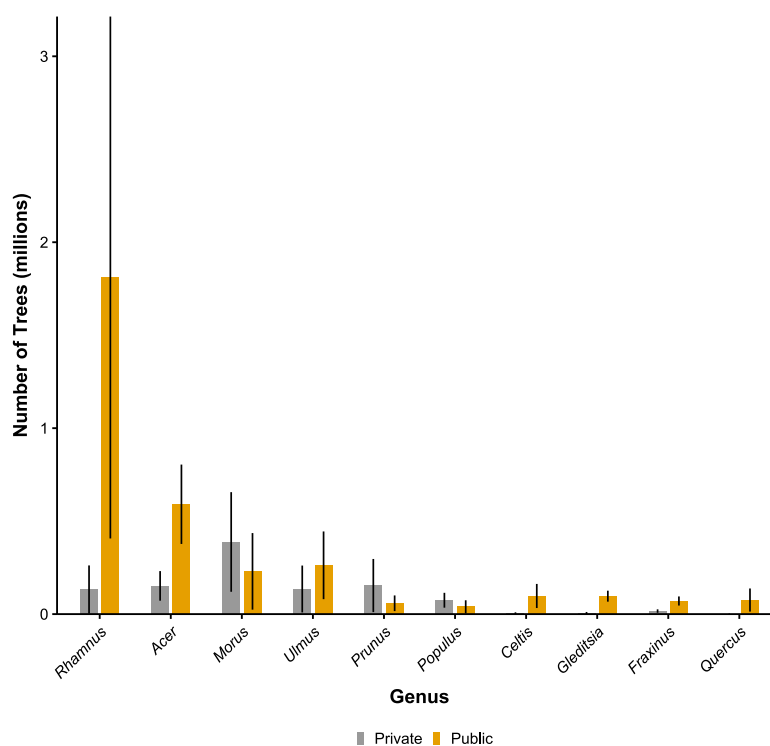


Figure 9.—Number of trees by genera within ownership classes for the 10 most common genera, Chicago, 2019. Error bars represent 68 percent confidence intervals around the estimated means.

Table 15.—Top 10 tree species in maintained areas by number of trees, Chicago, 2019

Common name	Trees (number)	Percent of all maintained trees
Norway maple	232,000	15.4
silver maple	223,000	14.8
peach	149,000	9.9
Siberian elm	129,000	8.5
white mulberry	129,000	8.5
honeylocust	91,000	6.0
American elm	75,000	5.0
green ash	70,000	4.7
boxelder	49,000	3.3
American basswood	35,000	2.3

Trees in Maintained Areas

Overall, 32.3 percent of trees in Chicago are classified as growing in maintained areas. Maintained areas are those which are regularly impacted by mowing, weeding, cutting, brush clearing, herbicide applications, and other treatments. Examples of maintained areas include, but are not limited to, lawns, shrub and flower beds, rights-of-way, and manicured parks. However, a tree found in a maintained area has not necessarily received care. In Chicago, the most common tree species in maintained areas are Norway maple (15.4 percent of all trees in maintained areas), silver maple (14.8 percent), and peach (9.9 percent) (Table 15).

Leaf Area

Leaf area is correlated with many ecosystem services provided by the urban forest. It is estimated as the surface area (on one side) of the leaves on a given tree or in an area. The proportion of total leaf area is greatest for trees 29.1 inches in diameter or greater (21.2 percent), followed by 27.1–29.0 inches in diameter (10.1 percent), and 17.1–19.0 inches in diameter (8.1 percent) (Fig. 10). In Chicago, the proportion of leaf area is greatest in rights-of-way land uses (47 percent of total leaf area), followed by residential (21.3 percent), and forest land uses (14.6 percent)(Fig. 11).

Leaf Area Index (LAI) refers to a standardized measure of leaf surface area per unit of tree cover and is calculated as the total leaf area divided by the total ground area covered by tree canopies. Higher LAI values indicate a greater depth or layering of leaves in the tree canopy. As each land use class has a different amount of area covered by trees, LAI allows for standardized comparison of leaves per unit canopy area among land use classes (acres of leaves per acre of tree cover). The leaf area index in land uses with trees ranges from 12.1 in forest land use to 3.1 in multi-family residential (Fig. 11).

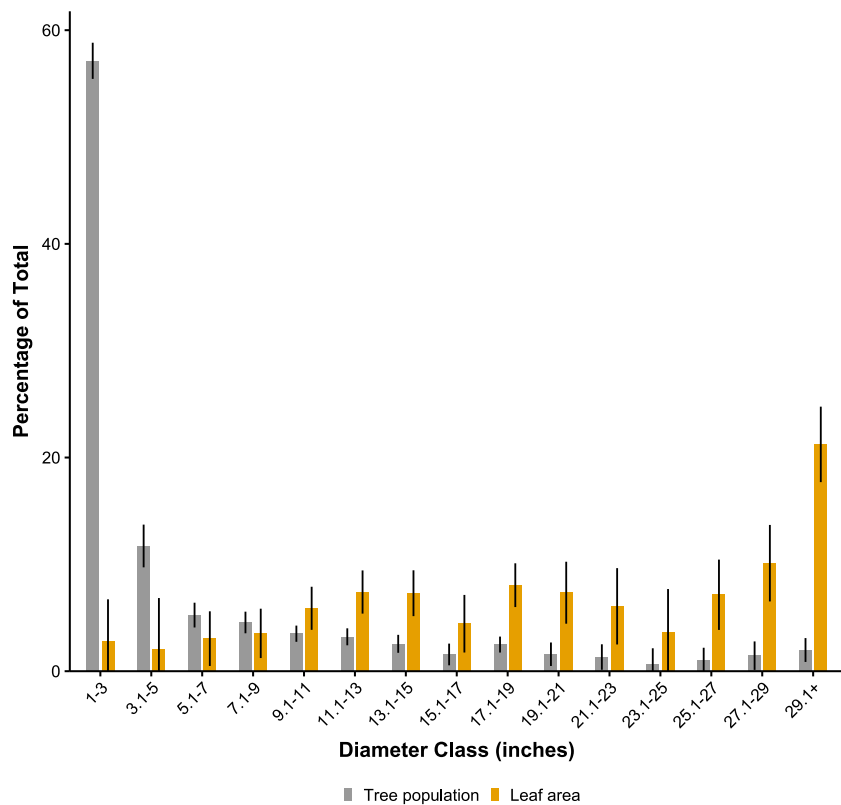


Figure 10.—Percent of tree population and leaf area by 2-inch diameter class, Chicago, 2019. Error bars represent 68 percent confidence intervals around the estimated values.

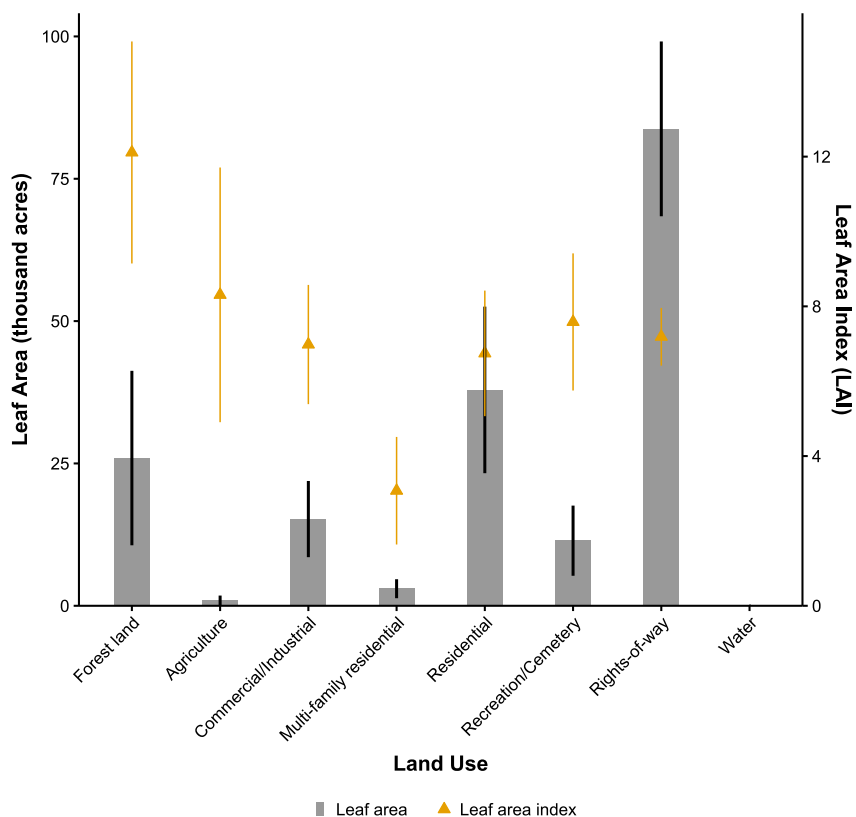


Figure 11.—Leaf area and LAI by FIA land use, Chicago, 2019. Error bars represent 68 percent confidence intervals around the estimated values.

Species Importance

Importance values (IVs) establish the relative contribution of the observed species to the overall species composition of the urban forest and are calculated by summing the values of its relative leaf area and relative abundance. High importance values do not mean that these trees should be encouraged in the future, but rather that they currently dominate the urban forest structure in terms of their population size and leaf area. The species in Chicago's urban forest with the greatest IVs are common buckthorn (44.7), silver maple (28.5), and Norway maple (18.3) (Table 16).

Table 16.—Percent of total tree population represented by tree species with the highest Importance Value (IV), Chicago, 2019

Common Name	Population (percent)	Leaf area (percent)	IV
common buckthorn	41.5	3.2	44.7
silver maple	4.8	23.7	28.5
Norway maple	5.0	13.3	18.3
white mulberry	13.1	5.0	18.1
eastern cottonwood	2.4	15.0	17.4
boxelder	5.5	3.3	8.8
Siberian elm	6.6	1.7	8.3
honeylocust	2.2	5.7	7.9
hackberry	2.2	2.1	4.3
green ash	1.5	2.2	3.7

IV = Population (%) + Leaf area (%).

VOLUME AND BIOMASS



Although common buckthorn account for the highest number of trees, it is the big trees, like this massive cottonwood, that hold the most volume in the urban forest. USDA Forest Service photo by Cherie Fisher.

Wood Volume and Value

Wood volume is a measure of the solid content of the tree stem and is used to estimate wood quantity. A detailed description of methods used to compute wood volume in terms of net cubic foot volume and sawtimber volume for this report is presented in Baer et al. (2024). Understanding the net volume of wood provided by a community's trees can serve a variety of purposes. From a management perspective, a thorough knowledge of wood volume can help predict potential storm damage and support planning for post-disaster recovery, including debris removal and cost. Volume data can also inform urban wood markets, which add value to traditional wood waste derived from tree removal, storm damage, and general tree maintenance. Such data can incentivize repurposing wood waste into traditional wood products such as lumber, handcrafted furniture, nature-based landscape supplies, and biofuel (Nowak et al. 2019).

In Chicago, live trees at least 5.0 inches in diameter are estimated to contain 52.4 million cubic feet of net volume and 90 million board feet of net sawtimber volume. To put this value in perspective, the median size of American homes constructed in 2019 was 2,301 square feet (US Census Bureau 2020a), which would require roughly 14,500 board feet to construct, assuming 6,300 board feet are required to construct 1,000 square feet of living space. Thus, the net sawtimber volume of Chicago's urban forest is roughly equivalent to the amount of wood needed to construct 6,204 median-sized homes. Silver maple contributes the greatest net cubic-foot volume at 31.5 percent of the city's total (Table 17). Eastern cottonwood contributes 48.6 percent of the total net board-foot sawtimber volume (Table 18). By diameter class, the greatest net cubic volume is provided by trees 29.1 inches or greater in diameter (Fig. 12).

Table 17.—Net cubic-foot volume for tree species with greatest net volume, Chicago, 2019

Common Name	Net Volume (cubic feet)	Standard Error (cubic feet)	Net Volume (percent)
silver maple	16,490,000	4,470,000	31.5
eastern cottonwood	10,280,000	5,700,000	19.6
Other species	7,910,000	1,490,000	15.1
Norway maple	6,060,000	1,500,000	11.6
honeylocust	2,690,000	817,000	5.1
white mulberry	2,570,000	908,000	4.9
black oak	1,930,000	1,850,000	3.7
bur oak	1,540,000	1,480,000	2.9
northern red oak	1,130,000	914,000	2.2
white ash	991,000	672,000	1.9
hackberry	821,000	458,000	1.6
Total	52,410,000	8,850,000	100.0

Due to rounding, not all values will add up exactly.

Table 18.—Net board-foot sawtimber volume for tree species with greatest net volume, Chicago, 2019

Common name	Net volume (board feet)	Standard Error (board feet)	Net volume (percent)
eastern cottonwood	43,710,000	25,350,000	48.6
silver maple	19,550,000	8,020,000	21.7
bur oak	6,070,000	5,820,000	6.7
northern red oak	5,380,000	4,310,000	6.0
black oak	4,680,000	4,490,000	5.2
white ash	2,850,000	2,740,000	3.2
black cherry	2,800,000	2,690,000	3.1
London planetree	2,330,000	2,230,000	2.6
honeylocust	1,540,000	1,480,000	1.7
black walnut	599,000	632,000	0.7
Other species	457,000	438,000	0.5
Total	89,970,000	30,210,000	100.0

Due to rounding, not all values will add up exactly.

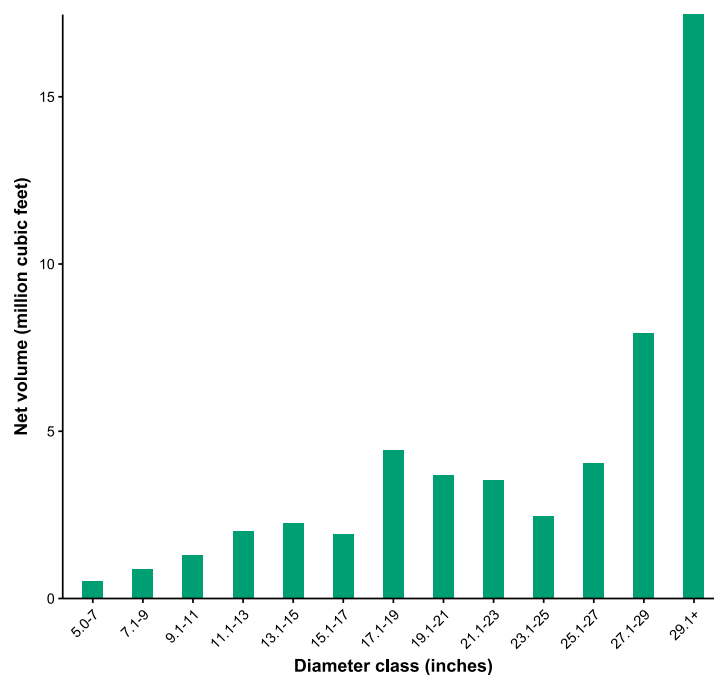


Figure 12.—Net Cubic volume by tree diameter class, Chicago, 2019.

While sawtimber could potentially be derived from urban forests to provide economic value, the broader social-ecological value of this forest is derived from healthy trees. Healthy urban forests provide benefits that support environmental and human health and well-being and are valued at over \$18 billion per year nationally (Nowak and Greenfield 2018). Harvesting healthy urban trees will reduce these local annual benefits. Utilizing urban wood waste, however, does not affect the healthy tree canopy and augments the value of the urban forest. Urban wood waste could produce between \$89 million and 786 million per year nationally depending upon the product derived (e.g., wood chips to lumber; Nowak et al. 2019).

Increasing public interest in environmentally responsible and sustainable products presents opportunities for urban wood utilization programs. In urban settings, trees generally only become a source for wood products after removal for development purposes or because of safety factors including age, pest and disease damage, or storm events. Many of these urban trees are unsuitable for traditional sawtimber products but may still have economic and cultural value. Methods to evaluate the quality of urban wood for potential products are not well defined since wood markets and products are quite varied across different geographic areas. Further research would allow for the development of metrics to evaluate the amount of urban wood waste available for specialty products. For example, many consumers of urban wood are interested in wood with grain character. Character wood that contains knots, insect damage and distorted grain is often highly desirable for specialty products, but these are the same wood qualities that make for less desirable traditional lumber. Urban wood waste utilization programs and markets may be better informed by drawing upon available FIA information about net growth, removals, and mortality.

Biomass

Like wood volume, tree biomass information is important in estimating both wood production and carbon storage. The overall aboveground biomass of all live trees in Chicago is estimated at 2,199,000 green tons (Table 19). The amount of biomass stored by live trees in Chicago varies by species. The tree species with the greatest total aboveground biomass are silver maple (26.6 percent), eastern cottonwood (16.9 percent), and Norway maple (11.5 percent) (Table 19).

Table 19.—Aboveground biomass (green tons) for tree species with the greatest biomass, Chicago, 2019

Common Name	Biomass (green tons)	Standard Error (green tons)	Biomass (percent)
silver maple	586,000	158,000	26.6
eastern cottonwood	371,000	202,000	16.9
Norway maple	253,000	62,000	11.5
white mulberry	168,000	60,000	7.6
honeylocust	158,000	49,000	7.2
black oak	101,000	97,000	4.6
bur oak	68,000	66,000	3.1
northern red oak	57,000	46,000	2.6
ailanthus	40,000	22,000	1.8
boxelder	40,000	22,000	1.8
Other species	357,000	64,000	16.2
Total	2,200,000	365,000	100.0

Due to rounding, not all values will add up exactly.

URBAN FOREST VALUES



Trees provide benefits to city residents, such as removing pollutants from the air, and reducing the amount of energy needed for cooling by shading homes in the summertime. USDA Forest Service photo by Sjana Schanning.

Urban forest values can be quantified as functional or structural. Social and biophysical functional values, either positive (e.g., decreased energy use) or negative (e.g., increased energy use) are based on the annual functions the trees perform, including sequestering carbon, removing air pollutants, and influencing surrounding microclimates which affects the amount of energy used to heat or cool buildings. The urban forest may provide many other functional values that are not quantified in this report (e.g., reduction in ultraviolet radiation, wildlife habitat, enhanced recreational opportunities, fostering social cohesion, and community health and well-being). Thus, the estimates provided in this report represent only a portion of the total urban forest functional values. Structural values include the amount of carbon stored by a tree and the tree's compensatory value, which can be thought of as the replacement value of the tree. Structural and functional values tend to increase with increased number and size of healthy trees and are usually on the order of several million dollars per year at a city scale.

Forest management activities can increase the values and services provided by the urban forest. However, these values and benefits can also decrease if the amount of healthy tree cover declines. Various costs associated with urban forest management, such as tree pruning, inspection, removal and disposal are not accounted for in this assessment and may offset some of the estimated monetary benefits described here (McPherson et al. 2005).

Urban forest ecosystem services associated with air pollution removal, avoided runoff, carbon sequestration, and compensatory value exclude dead trees, as these benefits are mainly based on existing leaf area, leaf biomass, or live tree conditions. However, standing dead trees do contribute to carbon storage and energy effects and are included in estimates for these values.

Air Pollution Removal

Poor air quality is a common problem in urban areas. Air pollution can adversely affect human health through increased rates of pulmonary, cardiac, vascular, and neurological diseases and mortality (Pope et al. 2002), along with negatively impacting ecosystem processes and reducing visibility. Urban forests can improve air quality by directly removing pollutants from the air and reducing energy consumption by buildings, which consequently reduces air pollution emissions from power plants and other energy sources. While trees emit volatile organic compounds (VOCs) that can contribute to ozone (O_3) formation (Fehsenfeld et al. 1992, Karlik and Pittenger 2012), integrative studies have revealed that an increase in tree cover tends to reduce O_3 formation, although the extent to which this is the case depends upon species composition (Calfapietra et al. 2013; Manes et al. 2012; Nowak et al. 2000, 2006).

Pollution removal by the urban forest in Chicago is greatest for O_3 (574.9 tons per year), followed by nitrogen dioxide (NO_2 ; 139.2 tons per year), particulate matter less than 2.5 microns ($PM_{2.5}$; 33.9 tons per year), sulfur dioxide (SO_2 ; 18.0 tons per year), and carbon monoxide (CO; 8.0 tons per year) (Fig. 13). The economic value of this pollution removed is estimated using i-Tree methodology in one of two ways, depending on the pollutant. For NO_2 , SO_2 , O_3 , and $PM_{2.5}$, estimates are based on avoided health effects due to lower pollution concentrations. For CO, the estimated value is based on the avoided externality costs of air pollution to society (Nowak 2021). The estimated value associated with pollution removal is greatest for $PM_{2.5}$ (\$19.68 million), followed by O_3 (\$7.62 million), NO_2 (\$295,000), SO_2 (\$14,000), and CO (\$11,000) (Table 20). It is estimated that trees in Chicago remove a total of 774 tons of air pollution per year with an associated value of \$27.6 million. More information about value calculations can be found in Baer et al. 2024.

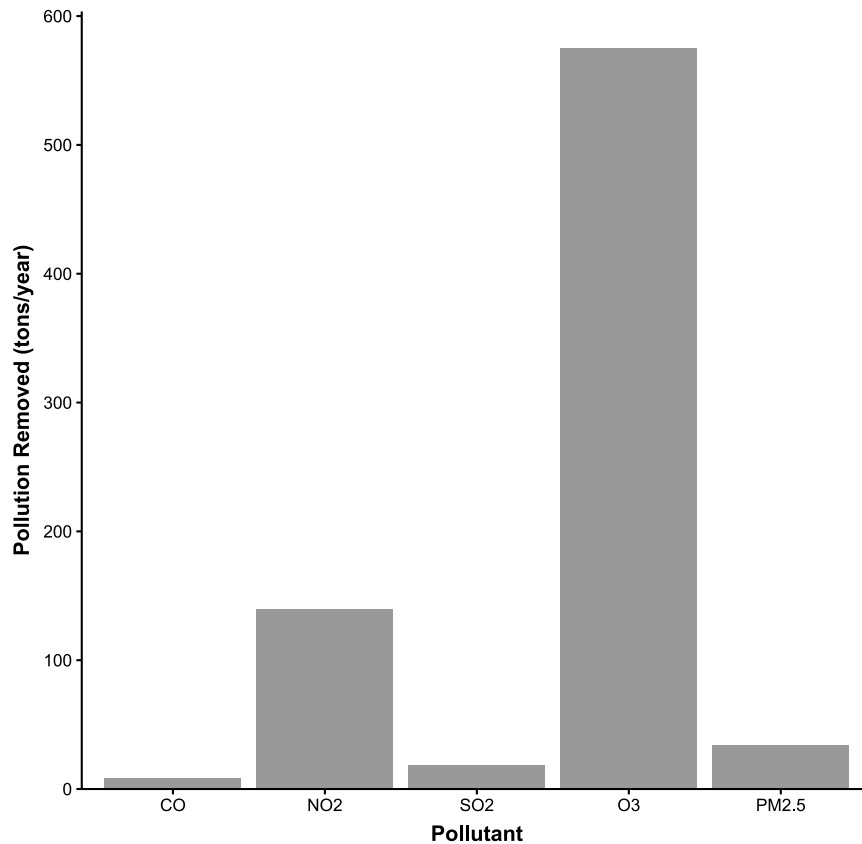


Figure 13.—Air pollution removal in Chicago's urban forest, 2019.

Decreases in the concentration of various air pollutants due to removal by trees is expected to have a positive effect on human health in Chicago (Nowak et al. 2014, U.S. EPA 2012). Using measured field data and pollution data from 2015, air quality improvements from trees produce numerous health benefits including an estimated 2791 fewer cases of acute respiratory symptoms per year with an associated value of over \$243,000 (Table 20).

Trees in Chicago emit an estimated 506 tons of VOCs (287 tons of isoprene and 219 tons of monoterpenes) per year. Emissions vary among species based on species characteristics (e.g., some genera such as oaks are high isoprene emitters) and leaf biomass. Aspen and oak (*Quercus* spp.) contribute 70.9 percent of VOC emissions (Fig. 14). These VOCs are precursor chemicals to ozone formation.

Table 20.—Incidence (number of cases per year) and associated value (dollars per year) of avoided health effects from changes in pollution concentrations due to pollution removal by trees in Chicago urban forest using 2016 atmospheric conditions.

Health effect	NO ₂ cases/yr	NO ₂ \$/yr	SO ₂ cases/yr	SO ₂ \$/yr	O ₃ cases/yr	O ₃ \$/yr	PM _{2.5} cases/yr	PM _{2.5} \$/yr
Acute Bronchitis	-	-	-	-	-	-	1.4	120
Acute Myocardial Infarction	-	-	-	-	-	-	0.7	60,000
Acute Respiratory Symptoms	120.0	3,700	5.2	160.0	1,800.0	155,000	860.0	84,000
Asthma Exacerbation	1,700.0	144,000	46.1	3,600.0	-	-	590.0	48,000
Chronic Bronchitis	-	-	-	-	-	-	0.7	188,000
Emergency Room Visits	1.6	660	0.2	91.1	0.9	390	0.9	390
Hospital Admissions	4.9	147,000	0.3	10,000.0	2.6	80,000	-	-
Hospital Admissions, Cardiovascular	-	-	-	-	-	-	0.3	13,000
Hospital Admissions, Respiratory	-	-	-	-	-	-	0.3	10,000
Lower Respiratory Symptoms	-	-	-	-	-	-	17.4	900
Mortality	-	-	-	-	0.9	7,320,000	2.5	19,250,000
School Loss Days	-	-	-	-	680.0	67,000	-	-
Upper Respiratory Symptoms	-	-	-	-	-	-	13.9	620
Work Loss Days	-	-	-	-	-	-	150.0	27,000
Total	1,800.0	295,000	51.9	14,000.0	2,500.0	7,620,000	1,600.0	19,680,000

Due to rounding, not all values will add up exactly.

Dash indicates that the value is not estimated for that pollutant and health effect. The same health effects were not analyzed for each pollutant.

Source: Understanding i-Tree: 2021 summary of programs and methods (Nowak 2021).

PM_{2.5} = particulate matter less than 2.5 microns.

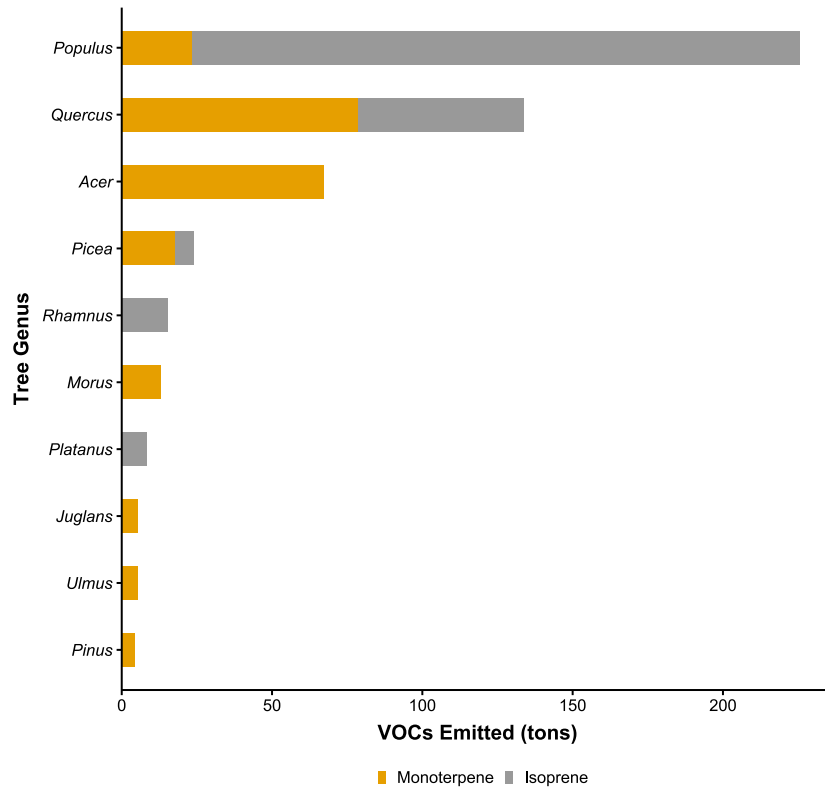


Figure 14.—Volatile organic compound emissions by genus, Chicago, 2019.

Avoided Runoff

Surface water runoff (commonly referred to as surface runoff or stormwater runoff) can contribute pollution to streams, wetlands, rivers, and oceans. During precipitation events, some portion of the precipitation is intercepted by vegetation, while the remainder reaches the ground. The portion of the precipitation that reaches the ground and does not infiltrate into the soil or end up in surface depression storage becomes surface runoff (Hirabayashi 2013). In urban areas, the large extent of impervious surfaces increases the amount of surface runoff.

Urban trees can reduce surface runoff. Tree canopies intercept precipitation, while root systems promote infiltration and water storage in the soil. The amount of avoided runoff is less than the total amount intercepted because soils also absorb precipitation and thus reduce runoff in the absence of trees. The trees in Chicago are estimated to reduce runoff by 62 million cubic feet per year (465 million gallons annually), with an estimated value of \$4 million/year (Baer et al. 2024). The majority of this avoided runoff is attributable to interception by tree canopies. Tree species with the greatest overall impact on runoff are silver maple, eastern cottonwood, and Norway maple due to their large leaf surface area (Fig. 15).

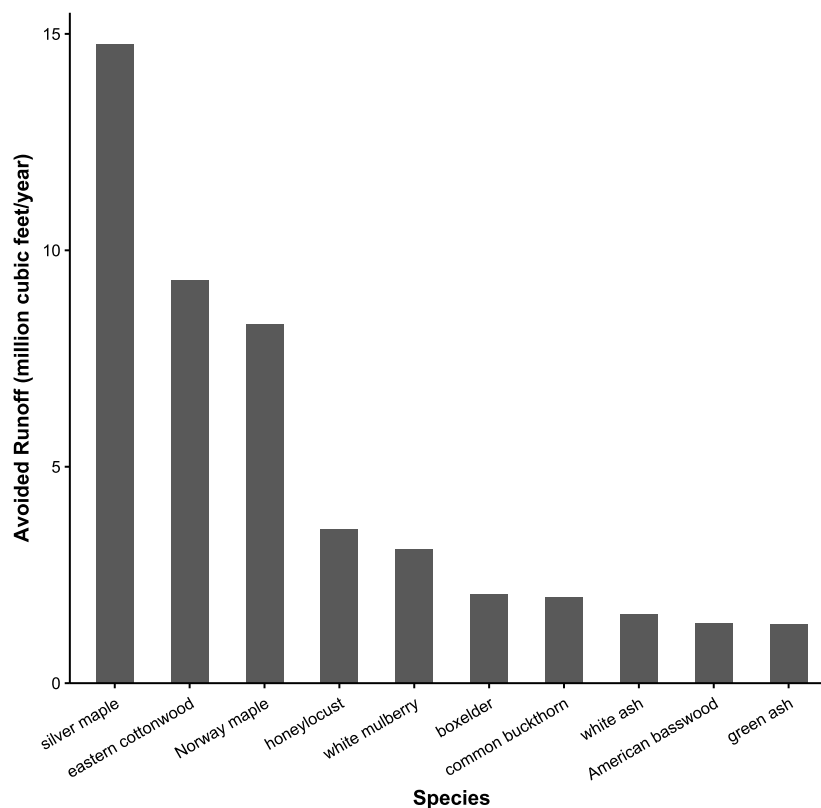


Figure 15.—Avoided runoff for 10 tree species with the greatest leaf area, Chicago, 2019.

Energy Conservation

Trees can affect building energy use by shading buildings, providing evaporative cooling, and blocking winter winds. Trees tend to reduce building energy consumption in the summer months (cooling season) and can either increase or decrease building energy use in the winter months (heating season), depending on the location of the trees around the building (Heisler 1986, Nowak et al. 2017). Estimates of tree effects on energy use are based on field measurements of the tree distance and directions to space-conditioned residential buildings (McPherson and Simpson 1999, Nowak et al. 2008a, Nowak 2020; U.S. EIA 2012a, b; 2014a, b, c).

In Chicago, interactions between buildings and trees 5.0 inches in diameter and greater are projected to annually increase energy requirements by 95,000 gigajoules (GJ) during the heating and cooling seasons (an energy equivalent of 601,350 gallons of home heating fuel oil) (Table 21), with an annual savings in energy costs of \$1.8 million based on average energy costs in 2012 (Table 22). Trees in the urban forest also are estimated to increase carbon dioxide (CO₂) emissions from fossil-fuel-based power sources by 3,800 tons annually (1,000 tons of carbon; \$175,000), equivalent to the burning of over 2.6 million pounds of coal or roughly 7,918 barrels of oil (Hong and Slatick 1994, U.S. EPA 2020). More information about value calculations can be found in Baer et al. 2024.

Table 21.—Annual energy savings^a (GJ or tons) due to trees 5+ inches in diameter near residential buildings, Chicago, 2019

Reduced energy use and emissions	Cooling	Heating	Total
Carbon avoided (tons) ^b	4,300	-5,300	-1,000
Energy effects (GJ) ^c	102,000	-196,000	-95,000

^a Negative values indicate an increase in energy requirements.

^b To convert carbon estimates to carbon dioxide, multiply carbon value by 3.667.

^c GJ = gigajoule (one billion [10⁹] joules).

Table 22.—Annual monetary savings due to trees 5+ inches in diameter near residential buildings during heating and cooling seasons, Chicago, 2019

Reduced energy use and emissions	Cooling	Heating	Total
Carbon avoided	729,000	-903,000	-175,000
Energy effects	3,540,000	-1,720,000	1,820,000

Based on 2012 statewide energy costs (U.S. Energy Information Administration, 2012a, 2012b, 2014b, 2014c) and

2015 social cost of carbon (Interagency Working Group, 2013, U.S. Environmental Protection Agency, 2015).

Negative values indicate an increase in energy requirements.

Carbon Storage and Sequestration

Climate change is an issue of global concern that threatens vulnerable species and ecosystems (e.g., coral reefs, polar and coastal areas) along with food production, water resources, and human health (Intergovernmental Panel on Climate Change 2014). Reductions in the amount of energy required to heat or cool residential buildings (described in the energy conservation section of this report) lead to reduced CO₂ emissions from fossil-fuel based power sources (Abdollahi et al. 2000). Trees can also help mitigate climate change by annually sequestering atmospheric carbon (in the form of CO₂) and storing carbon in their accumulated tissue (i.e., biomass).

Carbon storage is an indication of the amount of carbon that can be released if trees are allowed to die and decompose or are consumed in a fire event. Although tree maintenance practices (e.g., pruning) can contribute to carbon emissions, maintaining healthy trees helps to retain carbon stored in trees (Nowak et al. 2002b). Using removed trees for wood products is one way to help forestall carbon emissions related to wood decomposition. Wood from removed trees can also be used to produce energy (e.g., heat or cool buildings), helping to reduce fossil-fuel based carbon emissions. Trees in Chicago store an estimated 754,787 tons of carbon (2.8 million tons of CO₂) valued at \$128.7 million (Table 23). Carbon storage varies across the city (Fig. 16), among land uses, and by species. The species that store the most carbon are silver maple, eastern cottonwood, and Norway maple (Fig. 17).

Larger trees store more carbon per tree due to their greater size. Trees with diameters of 29.1 or greater store the greatest amount of carbon both as a proportion of the total amount of carbon stored and on a per tree basis in Chicago (Figs. 18 and 19).

In addition to carbon storage, which accounts for past carbon sequestration, healthy trees continue to annually sequester carbon in new tissue growth. Gross sequestration by urban trees in Chicago is about 21,000 tons of carbon per year (77,000 tons per year of CO₂) with an associated value of \$3.6 million per year, which is roughly equivalent to the annual emissions associated with 15,200 passenger vehicles or energy usage by 8,400 homes (U.S. EPA 2020). Silver maple is estimated to sequester the most carbon of all species in the urban forest (22.2 percent of all sequestered carbon) (Fig. 20).

Estimates of carbon storage and sequestration in developed and undeveloped land uses, along with evaluations of tree growth, removals, and mortality by ownership, can aid in assessing impacts of proposed land use changes and in developing climate change strategies and targets.

Table 23.—Aboveground and belowground carbon (C) in live and standing dead trees by Forest Inventory and Analysis (FIA) land use, Chicago, 2019

FIA land use	Aboveground in live trees (tons C)	Belowground in live trees (tons C)	Total in standing dead trees (tons C)	Total (tons C)	Standard error (tons C)
Rights-of-way	309,000	59,000	0	369,000	75,000
Residential	120,000	23,000	4,700	148,000	57,000
Forest land	109,000	21,000	8,900	139,000	84,000
Commercial/Industrial	39,000	7,500	28	47,000	21,000
Recreation/Cemetery	25,000	4,900	0	30,000	16,000
Agriculture	11,000	2,100	0	13,000	13,000
Multi-family residential	7,300	1,400	0	8,800	5,800
Total	622,000	119,000	14,000	755,000	-
Standard Error	100,000	19,000	6,100	119,000	-

Due to rounding, not all values will add up exactly.

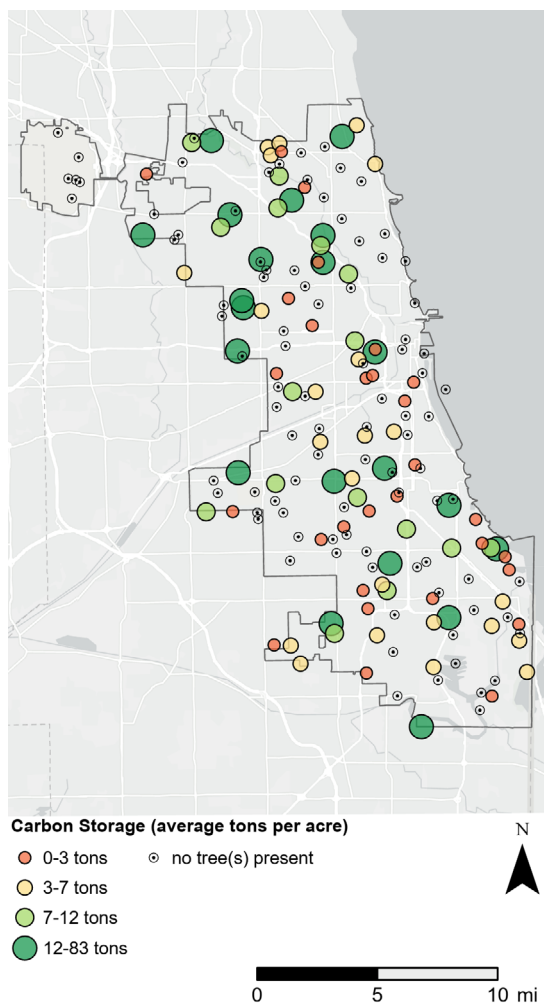


Figure 16.—Carbon storage per acre by plot, Chicago, 2019. Plot locations are approximate.

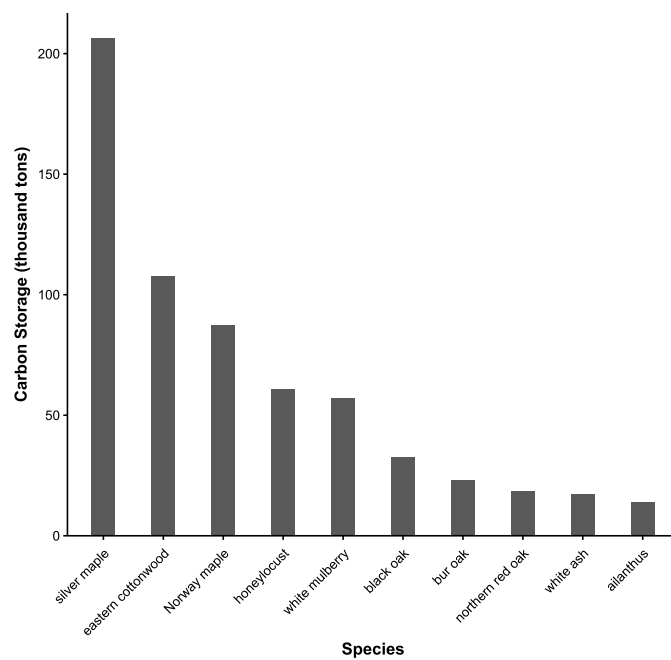


Figure 17.—Estimated carbon storage for 10 tree species with the greatest carbon storage, Chicago, 2019.

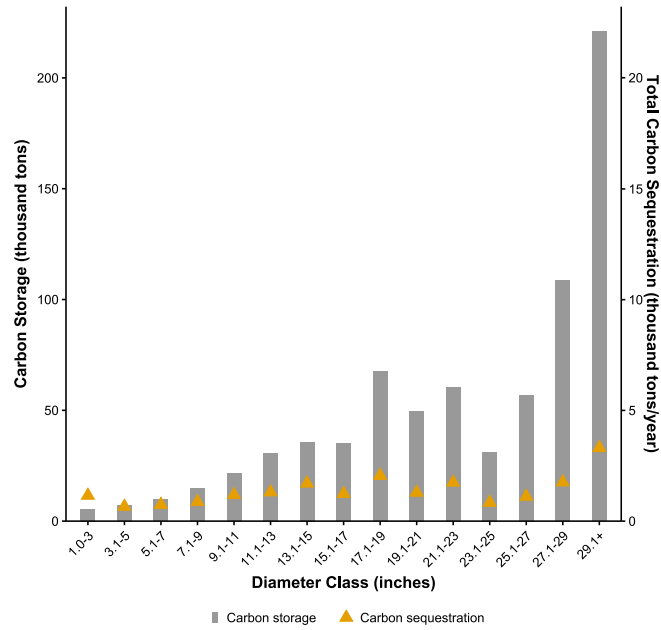


Figure 18.—Estimated total carbon storage and sequestration by diameter class, Chicago, 2019.

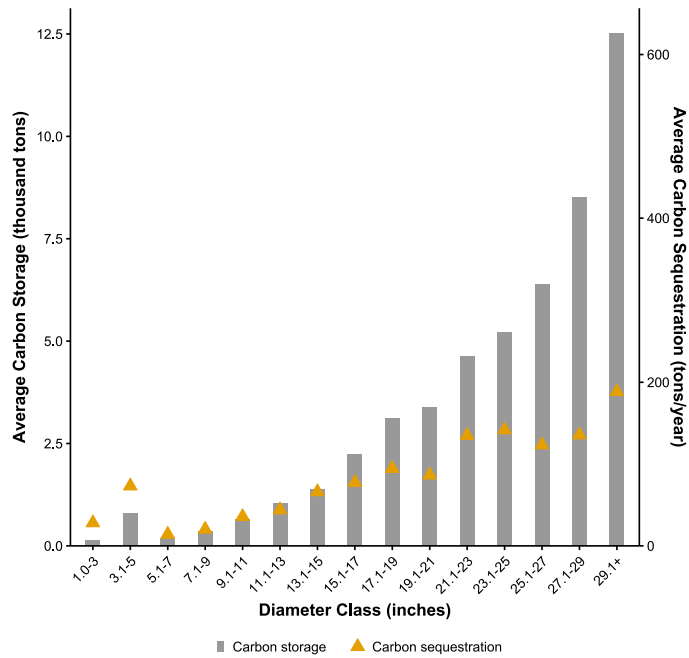


Figure 19.—Average per tree carbon storage and sequestration by diameter class, Chicago, 2019.

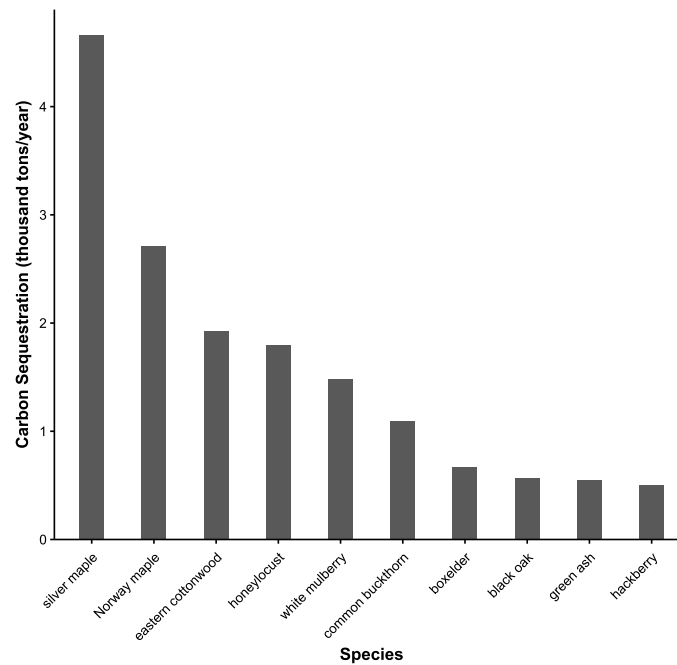


Figure 20.—Estimated annual carbon sequestration for 10 tree species with the greatest carbon storage, Chicago, 2019.

Structural Values

The city's urban forest has a structural value that includes the compensatory value and carbon storage value of each tree. The compensatory value is an estimate of the value of the tree as a structural asset, which tends to increase with the size and health of the tree. For small trees, a replacement cost can be used; for larger trees, appraisal procedures are used (Council of Tree and Landscape Appraisers 2000; Nowak et al. 2002a). This appraisal is an estimate based on tree species, diameter, condition, and location, and does not include many personal, social, functional, or future values that may be ascribed to a tree (Nowak and Aevermann 2019). Note that **invasive** tree species have compensatory values because the methods used to estimate compensatory value do not account for whether the species is native, non-native, or invasive. Additionally, invasive species can still contribute some ecosystem services. The compensatory value of the trees in Chicago is estimated to be about \$2.3 billion. This compensatory value is a function of the number, health, diameter, and species of all trees measured, as well as the land use in which they are encountered. The species with the largest compensatory values in Chicago are silver maple, Norway maple, and eastern cottonwood (Fig. 21). The mean compensatory value per acre for all surveyed plots in Chicago is \$14,368; for the 48.6 percent of these plots that contain trees, the mean compensatory value per acre is \$29,500 (Fig. 22). However, compensatory value per acre is estimated to exceed \$36,000 for 23 plots in which the average tree diameter is 16.2 inches. The structural value of urban trees in Chicago is a combination of their compensatory value (estimated at \$2.3 billion) and the value associated with carbon storage by the trees (estimated at \$128.7 million).

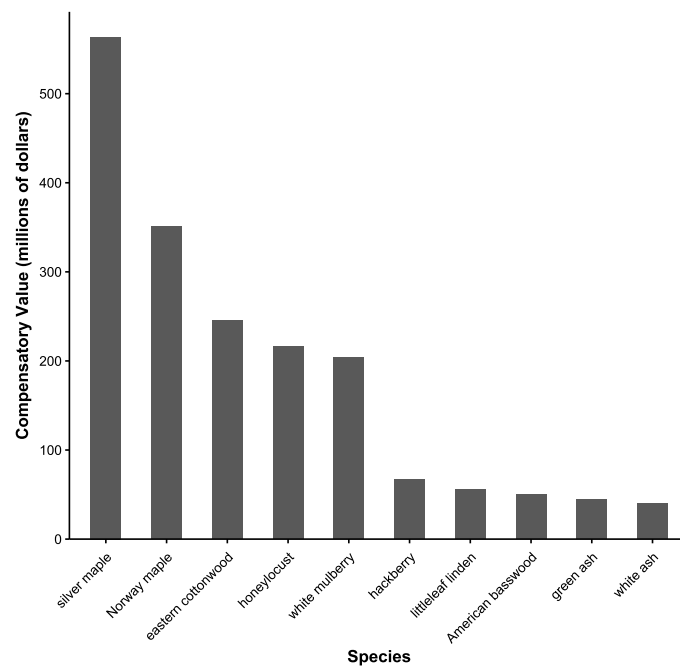


Figure 21.—Compensatory value by tree species, Chicago, 2019.

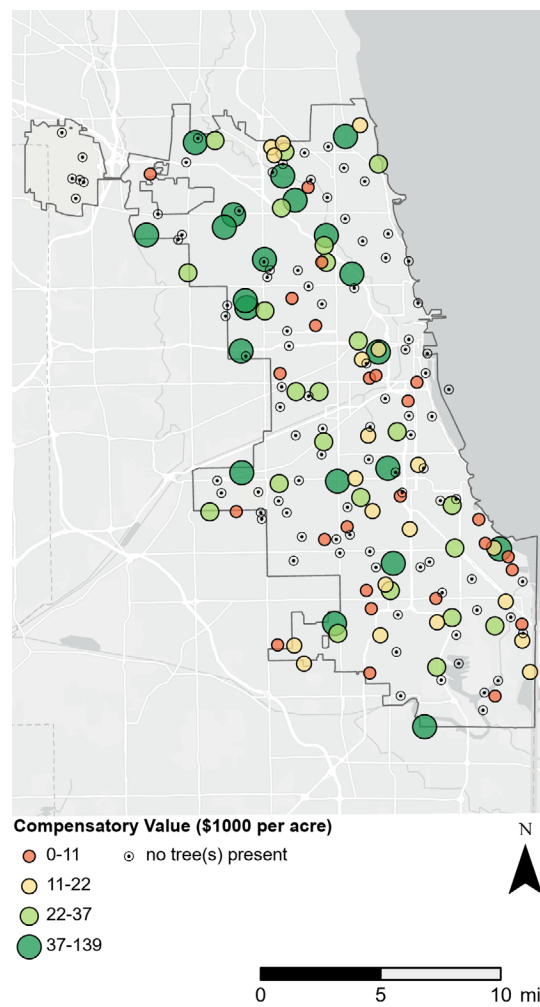


Figure 22.—Compensatory value per acre by plot throughout the sampling area, Chicago, 2019. Plot locations are approximate.

URBAN FOREST HEALTH



Bark inclusion, as shown here, causes weaker branch unions that can break. In populated areas, this can be a hazard for people and property, and resulting open wounds on the tree can lead to rot. USDA Forest Service photo by Thomas J. Brandeis.

A healthy urban forest provides greater benefits to society than an unhealthy one. This section highlights crown dieback, tree damages and rot, the number of standing dead trees, and the presence and prevalence of invasive plant species as indicators of urban forest health in Chicago. Detailed methods of invasive species as indicators of urban forest health metrics are presented in the Urban FIA NRS Field Guide Version 7.1 (USDA Forest Service 2017).



Crown Dieback and Bole Rot

Tree crown condition can be used as an indicator of tree health. Large, dense crowns are often indicative of vigorously growing trees, while small, sparsely foliated crowns signal trees with little or no growth. Crown dieback is one of the initial indications that a tree may be in a state of decline. Crown dieback is measured as a percentage of the crown volume with recent mortality of small fine branches and twigs in the upper and outer portion of the tree's crown. Trees with more than 25 percent crown dieback may be in decline (Steinman 2000). High levels of dieback may indicate an insect, disease, or environmental problem associated with a particular tree, tree species, or group of trees. Of the tree species that have a minimum sample size of 10 trees and show evidence of dieback, green ash has the highest average dieback (21.7 percent) (Table 24). Approximately 28.4 percent of green ash displays greater than 25 percent crown dieback, indicating that this species may be threatened by insect, disease, or environmental stressors in Chicago.

In addition to crown dieback, the amount of rot present in the trunk of a tree may indicate tree health issues and serve as a predictor of potential hazardous trees in urban areas. The percent of the main stem that was **rotten or cull** between 1 foot above the ground and approximately 4.0-inch top diameter outside of bark was recorded for all trees at least 5.0-inches in diameter. Of species with a minimum sample size of 10 trees, the species with the highest average rotten/cull amounts are Norway maple and silver maple (Table 25).

Table 24.—Tree species with greatest average dieback, Chicago, 2019

Species	Average dieback (percent)	Standard error (percent)	Trees with more than 25 percent dieback (percent)
green ash	21.7	40.5	28.4
ailanthus	5.5	5.4	0.0
silver maple	3.1	2.5	0.0
honeylocust	2.2	2.7	0.0
black cherry	1.9	2.5	0.0
Norway maple	1.9	2.0	0.0
common buckthorn	1.8	1.7	0.0
white mulberry	1.6	2.3	0.0
boxelder	1.4	1.1	2.3
Siberian elm	1.2	1.7	1.9
eastern cottonwood	0.9	1.3	0.0

Only species with minimum sample size of 10 live trees are included in this analysis to minimize effect of small sample size on percentage estimates.

Table 25.—Tree species with the greatest average rot, Chicago, 2019

Species	Average rot (percent)	Standard error (percent)	Trees with more than 15 percent rot (percent)
Norway maple	3.4	6.1	8.9
silver maple	3.2	5.1	11.2
honeylocust	2.2	5.0	10.3
black cherry	2.0	2.3	0.0
eastern cottonwood	1.6	2.6	0.0
ailanthus	1.4	1.9	0.0
boxelder	1.0	1.2	0.0
green ash	0.7	1.5	0.0

Estimates are rounded.
 Only species with minimum sample size of 10 live trees are included to minimize effect of small sample size on percentage estimates.
 Rot is only measured on trees greater than or equal to 5 inches in diameter.

Tree Damage and Potential Infrastructure Issues

Urban trees are susceptible to a wide range of insect, disease, and abiotic (e.g., soil compaction) damage agents that may affect tree survival, growth, and wood quality. Many damage agents are host specific and their impacts may vary by regional and local growing conditions. Live trees greater than 1.0 inch in diameter were examined for indications of several damage agents. Up to three damage agents were recorded per tree; each recorded agent was required to meet a minimum severity threshold (e.g., 20 percent of the foliage affected). If more than three damage agents were observed on a tree, the top three were prioritized according to their ability to do the following: (1) prevent the tree from surviving more than 1–2 years, (2) reduce the tree’s growth in the near term, and (3) negatively affect a tree’s marketable wood products. The full list of potential damage agents is presented in the Urban FIA NRS Field Guide Version 7.1 (USDA Forest Service 2017). Stem decay and imbedded objects are the most common causes of damage, affecting 21.1

and 13.3 percent of trees, respectively (Table 26).

Table 26.—Percentage of trees with observed damage, Chicago, 2019

Damage type	Percent
Cankers	0.1
General Insects	0.1
Human Activities	11.5
Stem Decay	21.1
Wild Animals	0.7
ash decline/yellows	0.1
black knot of cherry	0.1
emerald ash borer	1.0
imbedded objects	13.3
vine damage	2.0
Other Damages and Symptoms	
Other damages and symptoms	5.9
Broken top	0.4
Dead top	3.4
Dieback	0.2

In addition to damage agents, each live tree greater than 1.0 inch in diameter was evaluated for the presence of the following infrastructure issues that affect urban trees.

1. Root/stem girdling
2. Conflict with roots (sidewalk-root conflict/infrastructure damage)
3. Topping/pruning
4. Conflict with crown (branches within 5 feet of overhead wires)
5. Bark inclusion
6. Improper planting
7. Excessive mulch

Bark inclusion is the most common issue, occurring in 18.7 percent of trees. Topping/pruning and conflict with crown are the second and third most common urban-specific infrastructure issues, occurring in 4.8 and 3.6 percent of trees, respectively (Fig. 23).

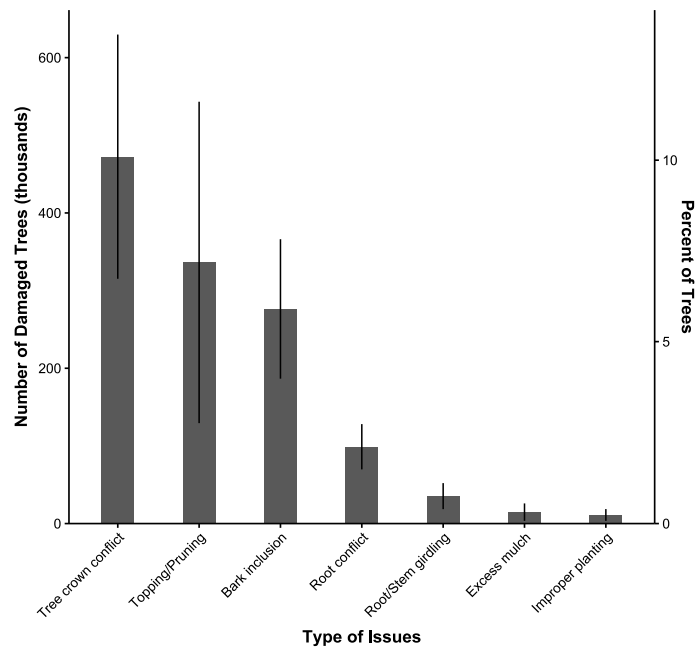


Figure 23.—Number and percent of trees by urban infrastructure issue category, Chicago, 2019. Error bars represent 68 percent confidence intervals around the estimated means.

Conflict with crown is the most common issue, occurring in 10.1 percent of trees. Topping/pruning and bark inclusion are the second and third most common urban specific infrastructure issues, occurring in 7.2 and 5.9 percent of trees, respectively (Fig. 23).

Differences exist in the prevalence of these issues among the FIA-designated land uses and may further inform urban forest health and management priorities. In Chicago, conflict with crown occurs in 45.6 percent of trees on residential land, severe topping or poor pruning in 39.1 percent of trees on commercial/industrial land, and conflict with crown in 36.2 percent of trees on multi-family residential land.

The species with the greatest proportion of their population affected by urban-specific damages are Siberian elm (38.9 percent affected by conflict with crown) and white mulberry (34 percent affected by topping/pruning) (Table 27, Appendix 5).

Table 27.—Species with greatest proportion of their population with infrastructure issues, by damage type, Chicago, 2019

Damage type	Species	Percent	Damage type	Species	Percent
Excess mulch	honeylocust	5.1	Topping/Pruning	white mulberry	34.0
	Siberian elm	1.5		ailanthus	8.9
Improper planting	green ash	7.4		eastern cottonwood	8.3
				green ash	6.7
Conflict with crown	Siberian elm	38.9		honeylocust	5.7
	silver maple	30.6		common buckthorn	3.7
	ailanthus	26.8		Norway maple	2.5
	green ash	23.1	Bark inclusion	white mulberry	14.2
	honeylocust	21.6		Norway maple	10.4
	eastern cottonwood	21.3		silver maple	8.9
	Norway maple	13.2		green ash	7.4
	white mulberry	9.5		eastern cottonwood	4.2
	boxelder	7.4		Siberian elm	3.8
Root/Stem girdling	Norway maple	8.6		boxelder	3.7
Conflict with roots	eastern cottonwood	9.7		common buckthorn	1.2
	ailanthus	8.9			
	green ash	7.4			
	Norway maple	6.8			
	silver maple	5.0			
	white mulberry	1.9			

Only species with minimum sample size of 10 live trees are included to minimize effect of small sample size on percentage estimates.

Standing Dead Trees

The number of standing dead trees serves as another measure of urban forest health and can be useful data for management planning. The extent to which a standing dead tree poses a threat to humans, infrastructure, or both depends on the location of the tree. Standing dead trees in maintained areas where human activity is likely high, such as residential and institutional land uses or transportation corridors, will generally be considered hazardous trees and prioritized for removal. Conversely, standing dead trees in patches of forest land away from heavy human use are of minimal risk, but beneficial for wildlife habitat and their removal may be deemed undesirable. Because of the variability of removal rates among land use classes, caution is advised when interpreting forest health issues based on numbers of standing dead trees.

Standing dead trees were found on seven plots in Chicago. Of the total live and dead tree population, 5.8 percent are estimated to be standing dead trees. The tree species with the highest percentage of standing dead trees are bitternut hickory, hawthorn spp., and unknown dead hardwood (Table 28). The species that makes up the largest proportion of the dead tree population is common buckthorn (Table 29). Land uses with the highest estimated number of standing dead trees are forest land, commercial/industrial, and residential (Fig. 24). The majority of standing dead trees are on unmaintained land in forest land uses.

Table 28.—Number of trees classified as standing dead by species, Chicago, 2019

Common name	Standing dead trees (number)	Standard error (number)	Percent of species
bitternut hickory	12,000	11,000	100.0
hawthorn spp.	5,800	5,600	100.0
unknown dead hard- wood	5,800	5,600	100.0
white ash	12,000	11,000	41.5
black cherry	23,000	18,000	28.6
ailanthus	14,000	15,000	21.1
common buckthorn	197,000	113,000	9.2
green ash	5,800	5,600	7.6
honeylocust	5,800	5,600	5.4
boxelder	4,700	5,000	1.8

Table 29.—Proportion of total dead tree population by species, Chicago, 2019

Common name	Standing dead trees (percent)
common buckthorn	68.9
black cherry	8.1
ailanthus	5.0
bitternut hickory	4.1
white ash	4.1
green ash	2.0
honeylocust	2.0
unknown dead hardwood	2.0
boxelder	1.7
Total	100.0

Due to rounding, not all values will add up exactly.

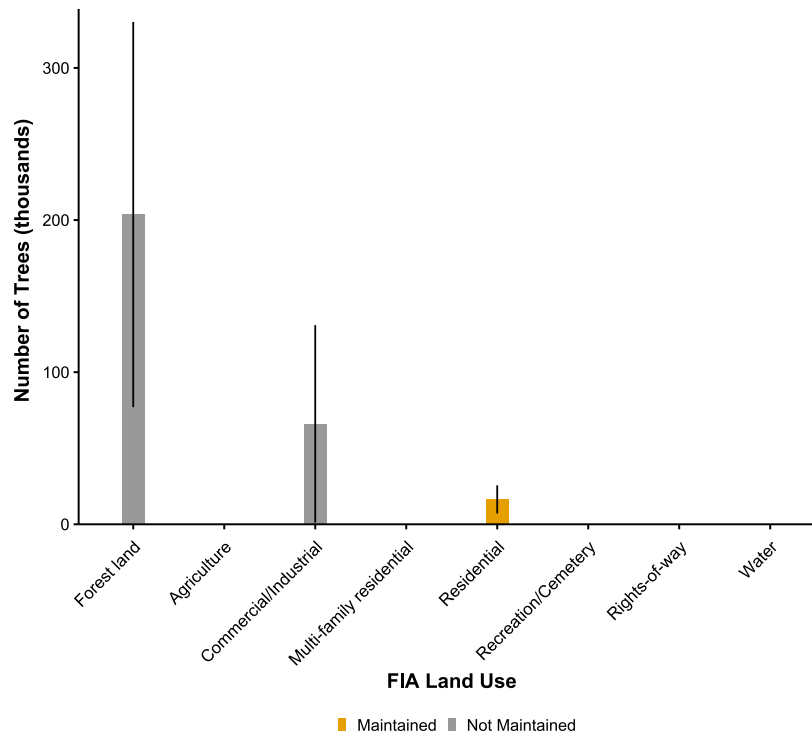


Figure 24.—Proportion of standing dead trees by land use and maintenance status, Chicago, 2019. Error bars represent 68 percent confidence intervals around the estimated means.

Invasive Plant Species

Invasive plant species are often noted for their vigor, ability to adapt to novel environments, high reproduction capacity, and lack of natural enemies. These factors may enable them to displace native plants and threaten natural areas (Davis 2009; Simberloff 2013). In accordance with Executive Order 13112 (1999), the USDA Forest Service defines an invasive species as a non-native species whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Important considerations for invasive plant control efforts include weighing short- and long-term trade-offs in terms of ecosystem services provided or disrupted by invasive species. The removal of invasive species and loss of ecosystem services they provide may lead to a subsequent need to increase the abundance of desirable species to offset these losses. Field crews in Chicago examined each plot for the presence of select invasive species based on a species list developed for the city (Appendix 6). Of the 183 plots examined, invasive species were identified on 54.6 percent (100 plots).

Invasive species found in Chicago are presented in (Fig. 25). Beyond noting simple presence or absence, crews noted the percentage of the plot area covered by the invasive species, allowing for the estimation of total area covered by each species within the city (Bechtold and Scott 2005). These estimated areas may offer insights into which species are having the greatest impact in the city. Of the invasive species recorded, Norway maple (5,342 acres; 3.5 percent of the sampling area), common buckthorn (1,725 acres; 1.1 percent of the sampling area), and tree of heaven (877 acres; 0.6 percent of the sampling area) cover the largest area. Of particular concern is the potential for these and other invasive species to spread beyond their current distribution into the surrounding landscape, potentially displacing native species and altering local ecosystems (Pimentel et al. 2000).

Additional measurements are recorded in the field for most tree species. As some of the species on the invasive plants list for Chicago are classified as trees, data on individual trees were collected in addition to descriptions of species cover on the plot. In Chicago, tree data were collected for ailanthus, common buckthorn, Norway maple, and Siberian elm. Taken together, these invasive trees are estimated to account for 54.2 percent of all live trees surveyed (estimated total trees: 2.5 million), and 20.4 percent of the total leaf area.

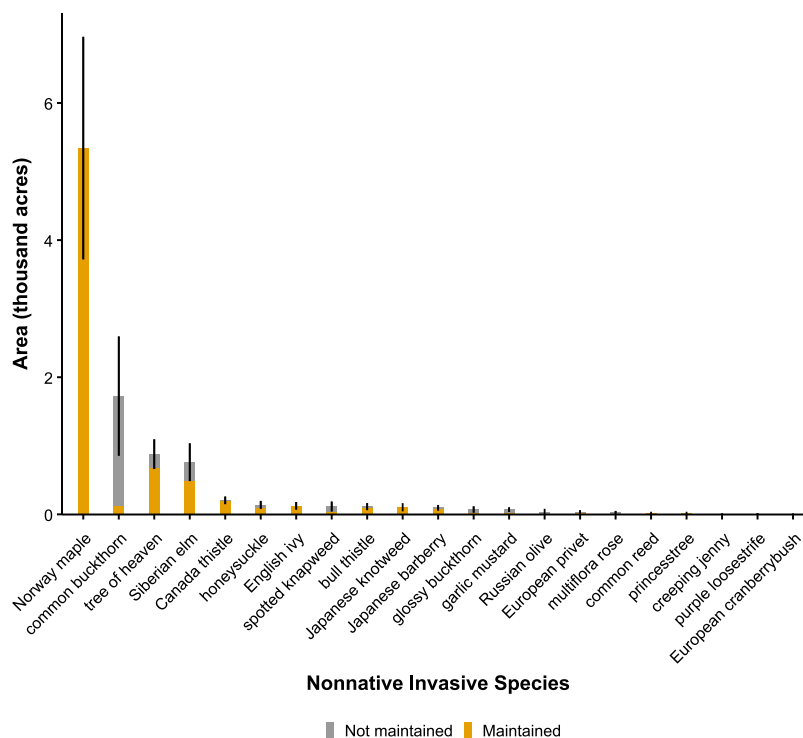


Figure 25.—Nonnative invasive species by maintained and unmaintained land, Chicago, 2019. Error bars represent 68 percent confidence intervals around the estimated means.

Pests and Pathogens

Pathogens and insect pests can affect the health, sustainability, and benefits of urban forests. Identifying pathogens and pests of concern and their potential host-specific impacts allows managers to prioritize specific insects and diseases for monitoring and control measures. We evaluated 45 insects and diseases, along with their tree hosts in Chicago, to quantify their potential impact on the urban forest (Table 30). The number of trees at risk (Figure 26) reflects all the known host tree species that could experience damage or mortality either directly or indirectly due to the pest or pathogen and does not necessarily include only trees that are known to be directly at risk of attack and/or infection. As FIA crews did not attribute tree damage or mortality to specific pests or pathogens, it was not possible to identify what portion of each host tree's population was directly at risk from or affected by the focal pests and pathogens. Pest range maps (Nowak 2021) were used to determine the proximity of each pest to the area. For Chicago, proximity was classified for insects and diseases in Cook or DuPage counties; within 250 miles of these counties; between 250 and 750 miles of the counties; or greater than 750 miles away. Since there are no pest range maps for Dutch elm disease (DED) and chestnut blight, the ranges of these pathogens were based on known occurrence and the known host range, respectively (Nowak 2021). Proximity data for insects and diseases, along with the numbers of trees potentially affected and their compensatory values, are illustrated in Table 30.

Based on the host tree species for each pest and the current range of the pest, it is possible to estimate the risk faced by each tree species sampled in the urban forest to attack by each of these insects or diseases and assign each tree species a relative risk weight. In Table 31, each pest that could pose a threat to a tree species is scored as 4 points if it occurs within Cook or DuPage County; 3 points if occurs within 250 miles of either of the counties; 2 points if it occurs within 750 miles of the counties; and 1 point if it is not present within 750 miles of either county. These values are summed across each row to determine the relative risk weight for each tree species recorded in the city.

Tree species that were sampled in Chicago, but are not listed in this matrix, are not known to be hosts to any of the 45 insects and diseases evaluated. This table also excludes the pests and diseases that were not a threat to any of the species sampled.

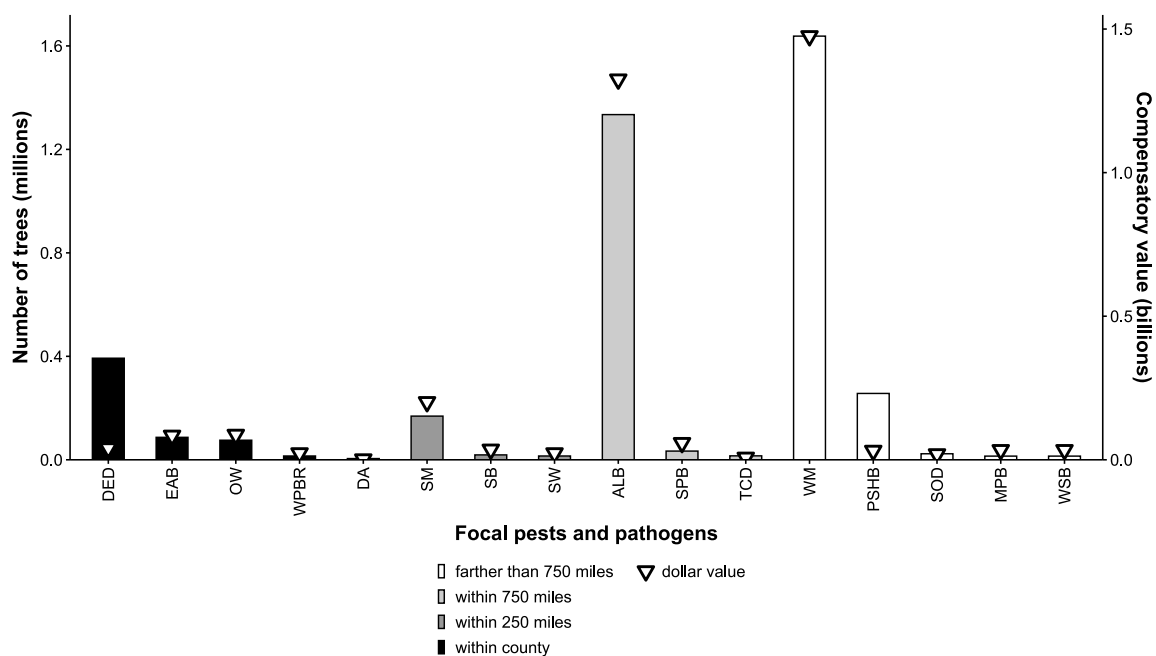


Figure 26.—Number of trees at risk due to pests and pathogens and their associated compensatory values, Chicago, 2019. Pest abbreviations are presented in Table 30.

Table 30.—Potential risk associated with various insects and diseases, Chicago, Illinois, 2019

Proximity (miles)	Abbreviation	Common name	Scientific name	Trees at risk (number)	Proportion of all trees (percent)	Compensatory value (dollars)
within county	DED	Dutch Elm Disease	<i>Ophiostoma ulmi</i>	392,742	8.4	40.2
within county	EAB	Emerald Ash Borer	<i>Agrilus planipennis</i>	86,874	1.9	84.2
within county	OW	Oak Wilt	<i>Ceratocystis fagacearum</i>	75,706	1.6	87.3
within county	WPBR	White Pine Blister Rust	<i>Cronartium ribicola</i>	14,710	0.3	23
within county	DA	Dogwood Anthracnose	<i>Discula destructiva</i>	4,738	0.1	1.8
within county	ARM	Armillaria Root Disease	<i>Armillaria spp.</i>	0	NA	NA
within county	BC	Butternut Canker	<i>Ophiognomonia clavignenti-juglandacearum</i>	0	NA	NA
within county	BOB	Bur Oak Blight	<i>Tubakia iowensis</i>	0	NA	NA
within county	LAT	Large Aspen Tortrix	<i>Choristoneura conflictana</i>	0	NA	NA
within county	PSB	Pine Shoot Beetle	<i>Tomicus piniperda</i>	0	NA	NA
within 250 miles	SM	Spongy Moth	<i>Lymantria dispar</i>	168,893	3.6	201.1
within 250 miles	SB	Spruce Beetle	<i>Dendroctonus rufipennis</i>	18,953	0.4	35.7
within 250 miles	SW	Sirex Wood Wasp	<i>Sirex noctilio</i>	14,710	0.3	23
within 250 miles	AL	Aspen Leafminer	<i>Phyllocnistis populiella</i>	0	NA	NA
within 250 miles	BBD	Beech Bark Disease	<i>Cryptococcus fagisuga/Neonectria spp. complex</i>	0	NA	NA
within 250 miles	CB	Chestnut Blight	<i>Cryphonectria parasitica</i>	0	NA	NA
within 250 miles	FTC	Forest Tent Caterpillar	<i>Malacosoma disstria</i>	0	NA	NA
within 250 miles	HRD	Heterobasidion Root Disease	<i>Heterobasidion annosum</i>	0	NA	NA
within 250 miles	HWA	Hemlock Woolly Adelgid	<i>Adelges tsugae</i>	0	NA	NA
within 250 miles	JPBW	Jack Pine Budworm	<i>Choristoneura pinus</i>	0	NA	NA
within 250 miles	SBW	Spruce Budworm	<i>Choristoneura freemani</i>	0	NA	NA
within 750 miles	ALB	Asian Longhorned Beetle	<i>Anoplophora glabripennis</i>	1,334,552	28.5	1324.6
within 750 miles	SPB	Southern Pine Beetle	<i>Dendroctonus frontalis</i>	33,663	0.7	58.7
within 750 miles	TCD	Thousand Canker Disease	<i>Geosmithia morbida</i>	15,300	0.3	7.7
within 750 miles	BWA	Balsam Woolly Adelgid	<i>Adelges piceae</i>	0	NA	NA
within 750 miles	FR	Fusiform Rust	<i>Cronartium quercuum</i> f.sp. <i>fusiforme</i>	0	NA	NA
within 750 miles	LWD	Laurel Wilt	<i>Raffaelea lauricola</i>	0	NA	NA
farther than 750 miles	WM	Winter Moth	<i>Operophtera brumata</i>	1,637,938	35.0	1475.4

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Table 30 (continued).

Proximity (miles)	Abbreviation	Common name	Scientific name	Trees at risk (number)	Proportion of all trees (percent)	Compensatory value (dollars)
farther than 750 miles	PSHB	Polyphagous Shot Hole Borer	<i>Euwallacea fornicatus</i>	256,512	5.5	31.6
farther than 750 miles	SOD	Sudden Oak Death	<i>Phytophthora ramorum</i>	23,294	0.5	19.6
farther than 750 miles	MPB	Mountain Pine Beetle	<i>Dendroctonus ponderosae</i>	14,214	0.3	34.0
farther than 750 miles	WSB	Western Spruce Budworm	<i>Choristoneura occidentalis</i>	14,214	0.3	34.0
farther than 750 miles	BM	Browntail Moth	<i>Euproctis chrysorrhoea</i>	0	NA	NA
farther than 750 miles	DBSR	Douglas-fir Black Stain Root Disease	<i>Leptographium wageneri</i> var. <i>pseudotsugae</i>	0	NA	NA
farther than 750 miles	DFB	Douglas-Fir Beetle	<i>Dendroctonus pseudotsugae</i>	0	NA	NA
farther than 750 miles	FE	Fir Engraver	<i>Scolytus ventralis</i>	0	NA	NA
farther than 750 miles	GSOB	Goldspotted Oak Borer	<i>Agrilus auroguttatus</i>	0	NA	NA
farther than 750 miles	JPB	Jeffrey Pine Beetle	<i>Dendroctonus jeffreyi</i>	0	NA	NA
farther than 750 miles	NSE	Northern Spruce Engraver	<i>Ips perturbatus</i>	0	NA	NA
farther than 750 miles	PBSR	Pine Black Stain Root Disease	<i>Leptographium wageneri</i>	0	NA	NA
farther than 750 miles	POCRD	Port-Orford-Cedar Root Disease	<i>Phytophthora lateralis</i>	0	NA	NA
farther than 750 miles	RPS	Red Pine Scale	<i>Matsucoccus matsumarae</i>	0	NA	NA
farther than 750 miles	SFM	Subalpine Fir Mortality	<i>na-multiple pests</i>	0	NA	NA
farther than 750 miles	WFNPM	Western Five-Needle Pine Mortality	<i>na-multiple pests</i>	0	NA	NA
farther than 750 miles	WPB	Western Pine Beetle	<i>Dendroctonus brevicomis</i>	0	NA	NA

Table 31.—Pest risk rating by tree species, Chicago, Illinois, 2019

Score	Common name	DED	EAB	OW	WPBR	DA	SM	SB	SW	ALB	SPB	TCD	WM	PSHB	SOD	MPB	WSB
9	Eastern white pine				4			3			2						
9	Northern red oak			4			3						1		1		
9	Pin oak			4			3						1		1		
8	Black oak			4			3						1				
8	Bur oak			4			3						1				
7	American elm	4								2			1				
7	Green ash		4							2			1				
7	Norway spruce							3			2					1	1
7	Siberian elm	4								2			1				
7	Slippery elm	4								2			1				
5	Chinese elm						3			2							
5	Red spruce							3			2						
5	White ash		4										1				
4	American basswood						3						1				
4	Boxelder									2			1	1			

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Table 31 (continued).

Score	Common name	DED	EAB	OW	WPBR	DA	SM	SB	SW	ALB	SPB	TCD	WM	PSHB	SOD	MPB	WSB
4	dogwood spp					4											
3	apple spp						3										
3	Callery pear						3										
3	Eastern cottonwood								2				1				
3	Littleleaf linden						3										
3	Norway maple								2				1				
3	Red maple								2				1				
3	Silver maple								2				1				
2	Black walnut											2					
2	Freeman maple								2								
2	London plane									2							
1	Black cherry												1				
1	Peach												1				

See Table 30 for a key to the pest and pathogen abbreviations used in this table.

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MANAGEMENT IMPLICATIONS



Trees in yards and parks, and even along major interstates create the urban forest. Having data about species, size, and location helps landowners and managers allocate resources and plan for the future. USDA Forest Service photo by Sjana Schanning.

The primary goal of Urban FIA is to provide an accurate estimate of the composition, distribution, health, and values of urban forests to aid in sustainable urban forest management and planning. This report presents information about the current state of the Chicago urban forest and the benefits it provides to residents of the city. A close inspection of these data can help planners understand where improvements can be made and develop tree planting and conservation goals for the future. The data will also serve as a baseline against which the future results from continued monitoring can be compared. These comparisons will allow managers to assess rates of tree growth and mortality, as well as changes in species composition, the distribution of size classes, and the corresponding changes in benefits associated with the urban forest. Effective monitoring allows for the development of data-driven management strategies to maximize the benefits of Chicago's urban forest while minimizing the cost associated with its maintenance.



Three Most Common Trees - Invasives

It is notable that the top three most prevalent tree species in Chicago (common buckthorn, white mulberry, and Siberian elm) are either listed invasive species, or have known invasive tendencies. These three species together represent 61.1 percent of the total tree count.

Common buckthorn is a listed invasive species and is illegal to sell in Illinois. Despite this, its ability for prolific seed production and stump sprouting has led it to far outnumber any other species sampled in Chicago with an estimated 1,942,000 stems (41.5 percent of total tree count). Almost all of these (97.9 percent) are under 5.0 inches in diameter. Although forestland accounts for only 1.6 percent of the sample area in Chicago, 93.3 percent of the buckthorn recorded occurred on this land use. All forest land sampled was owned by local government. Due to buckthorn's dense regeneration, it has the ability to dominate ecosystems and displace native species, altering forest conditions and threatening natural succession. Its heavy presence in the forested areas of Chicago suggests that these areas are likely already at risk for reduced regeneration of native trees and the benefits that they provide. The resulting decreased plant diversity may provide significantly less useful habitat for wildlife and considerably less enjoyable wooded areas for human use.

Due to the aggressive and invasive tendencies of white mulberry, The Morton Arboretum recommends that only non-reproducing cultivars be used for landscaping (The Morton Arboretum 2022). The data suggest that such guidance has been heeded, since only 4.4 percent of the estimated 612,000 white mulberry in Chicago is planted. Of those planted, none are under 5.0 inches in diameter which suggests that recent plantings of white mulberry are minimal. The majority (87.9 percent) are naturally regenerating trees under 5.0 inches in diameter, indicating that the species may continue to dominate the city's urban forest for years to come. Unlike common buckthorn, nearly all (99.2 percent) white mulberry occur on non-forest land with the majority of those (78.8 percent) growing in unmaintained areas which are not mowed, weeded, or actively landscaped. Areas which might qualify as unmaintained non-forest include overgrown vacant lots and narrow wooded areas between houses or commercial buildings that are not mowed or otherwise maintained. Commercial land uses hold 43.1 percent of all white mulberry, followed by parks with 35.1 percent and then residential lands with 16.8 percent.

Representing 6.6 percent of the total tree population in Chicago, Siberian elm is the third most abundant species in Chicago. The majority of these trees (58.0 percent) are on park land with another 38.9 percent on residential land. As with common buckthorn and white mulberry, most (85.5 percent) of the Siberian elm present are sapling size (less than 5.0 inches in diameter.)

Landscape planning. Climate change

Chicago temperatures and local climate are greatly impacted by Lake Michigan which provides a buffer to extreme highs of summer and lows of winter. According to the most recent USDA Plant Hardiness Zone map, most of the city is currently within zone 6a which represents average annual extreme minimum temperatures down to -10 degrees Fahrenheit (USDA ARS 2012). Within the city limits, summer temperatures can vary depending on wind direction, humidity, and additional localized conditions such as heat islands created by roads and other impervious surfaces. Despite moderation from Lake Michigan and localized conditions, Chicago's climate is not exempt from the challenges that come with global climate change. According to Chicago's 2022 Climate Action Plan, average temperatures have risen by 2.6 degrees Fahrenheit since 1980. Climate change forecasts for Illinois include continued increasing temperatures, increased spring rainfall and severe storms, and increased flooding, all while the severity of summer droughts increases (U.S. EPA 2016).

Which trees grow and thrive in Chicago depends upon the delicate balance of temperature extremes, humidity, growing season, precipitation amounts, soil conditions, and many other variables. Examination of the Urban FIA data can provide information about what tree species are currently present and the land uses and conditions in which they are growing. This information, alongside analysis of predicted climate conditions may help inform planning and planting strategies to develop and maintain an urban forest which can flourish into the future and continue to provide benefits to city residents.

Planting

Recruitment of new trees into urban forest can result from both natural regeneration and intentional planting. Across all land uses including forest land and non-forest land, 75.3 percent of Chicago's trees are naturally occurring, with more than half of those accounted for by sapling buckthorn growing primarily on forest land. On Chicago's non-forest land, trees established through natural means make up just over half (51.3 percent) of all trees. Planted trees account for 43.1 percent and, for the remaining 5.6 percent, it is unclear whether they were established through planting or natural regeneration. Although 81.3 percent of naturally propagating trees in non-forest areas are saplings, only 25.6 percent of the planted trees are saplings. Nearly half of the planted trees (48.1 percent) are 11-inches in diameter or greater. Since the number and size distribution of planted trees reflect intentional human effort toward development of the urban forest, close attention to these trees can increase understanding of how local interest, education, policy and funding impact planting efforts over time.

As observed throughout this report, large diameter trees provide significantly higher levels of ecosystem services than smaller trees. In this regard, the high proportion of 11.0 inch or greater diameter trees reflects the high level of benefits provided by Chicago trees. Continued development of the urban forest, however, depends on the successful growth of young saplings. The relatively low percentage of planted trees under 5.0 inches in diameter may be an area of concern, especially given high rates of mortality for newly planted saplings (Hilbert et al. 2019). Analysis of changes in the total counts and proportions of each size class will help to forecast whether Chicago residents can count on ongoing succession of trees or if they must increase planting efforts to ensure continued benefits. Additional investigation may help to identify whether the lower planted sapling proportion is due to recent reduced rates of tree planting or if recent plantings have been less successful due to lack of post-planting maintenance.

Energy Conservation

The presence of trees and their orientation in relation to residential buildings can have a large impact on the amount of energy savings they provide. On hot days trees can lower localized temperatures through evaporative cooling, and a tree on the sunny side of a house can provide shade, thereby reducing the energy necessary to cool the home. In the winter, trees can reduce the amount of energy needed to heat homes by blocking cold winds. During the winter months westerly winds are prevalent in Chicago (State Climatologist Office for Illinois [n.d.], Weatherspark 2022), so trees (especially conifers, which do not lose their leaves in the winter) situated west of residential houses can help reduce heat loss. Alternatively, trees on the south and southwest side of houses may also increase heating requirements in the winter by shading homes from warming sun.

As noted in the energy conservation section above, trees in Chicago are estimated to produce a net financial savings in energy costs of \$1.8 million while simultaneously leading to a net increase in annual energy consumption. Although Chicago trees provide significant energy savings by reducing cooling needs during the summer months, this is outweighed during winter months by less strategically located trees, which cause increased energy requirements to heat homes. The overall cost savings is due to the higher cost of the electricity used for summer cooling relative to the cost of fuels typically used for winter heating.

Current building energy use models take only residential buildings into account, and further research is needed to understand impacts on commercial or other building types. Providing information to homeowners about the impact of various tree species and planting locations on energy requirements and costs can help inform their decisions about planting and removing trees on their own property.

Ornamental and Fruit Trees

The Chicago region provides growing conditions which allow for the successful growth of several kinds of fruit and other ornamental trees, many of which were recorded in the Chicago sample. Together, peach, eastern redbud, Yoshino flowering cherry, dogwood and apple species have a total estimated population of just over 189,000 trees. Although not encountered in the sample, local knowledge⁵ suggests that trees such as other flowering cherry species (*Prunus* spp.), star magnolia (*Magnolia stellata*), edible pear (*Pyrus* spp.), and other fruiting and flowering trees used extensively in landscaping are represented by this total estimate. Where one landowner might choose to plant a cluster of peach, others may plant a selection of crabapple and magnolia.

While most of the ornamental trees encountered in this study are well centered within their geographic range, according to the USDA PLANTS database, eastern redbud in Chicago are situated very near its current northernmost range (USDA NRCS 2022). This ornamental species may thrive and gain popularity in the Chicago region as temperatures warm with the effects of climate change.

Insect and Disease Impacts

First detected in Chicago in 1998, the Asian longhorned beetle (*Anoplophora glabripennis*) was declared eradicated from the city in 2008 (USDA APHIS 2016, City of Chicago 2022b). Given the long list of species which can serve as hosts for this destructive invasive insect, the efforts which brought about this eradication have been critical in protecting more than 1.3 million trees - over 27 percent of Chicago's entire current urban forest tree count. As of April 2022, the closest known infestation of Asian longhorned beetle was just over 250 miles away near Cincinnati, OH (USDA APHIS 2022). Should the beetle return and become established, existing trees with a compensatory value of greater than \$1.3 billion could be at risk as well as significant future tree regeneration in Chicago (Fig. 26).

Although the Asian longhorned beetle serves as a potential threat, DED is a current and present risk to elm trees. Accounting for approximately 8.5 percent of the total tree count in the city, a deeper investigation of the threat DED presents to the urban forest is warranted.

⁵ Additional fruit and ornamental tree species present in Chicago were suggested through conversation with the Illinois Urban Forestry Administrator and staff of The Morton Arboretum.

The majority (77.2 percent) of elm in Chicago are the invasive Siberian elm which, although susceptible, show more resistance to DED than American or slippery elm. Significant research and development of DED resistant elm hybrids and cultivars has occurred through The Morton Arboretum elm improvement program and by other growers and horticulturalists. Given The Morton Arboretum's proximity to Chicago, it is likely that some percentage of the elm present in Chicago are carefully selected varieties planted specifically for their resistance to the disease. Additionally, nine such cultivars are included on the "City of Chicago Urban Tree Planting List" provided by the city's Bureau of Forestry (City of Chicago Bureau of Forestry, 2012). While these cultivars show improved resistance to DED, some level of susceptibility remains which should be taken into consideration when developing planting and management plans.

Within the Urban FIA data collection program, elms are not recorded to the variety or hybrid level. It is necessary therefore, to infer from the collected data which are most likely to be disease resistant. Of those elm present which are not Siberian elm, 81.4 percent are planted on public lands, and these are primarily less than five inches in diameter (80.8 percent). Given the expense of planting and planning required for public tree planting efforts, it is a reasonable expectation that these trees are disease resistant hybrids. When reviewing Tables 30 and 31 and Figure 26 included in this report, it is important to recognize that the values assume susceptibility of all elm present except for Chinese elm.

Emerald ash borer (*Agrilus planipennis*) is a destructive pest which causes the death of ash trees by tunneling through the sapwood, cutting off the access to nutrients and water. The presence of this exotic and invasive insect was first confirmed in Chicago in 2008 (City of Chicago 2022c). Since then, city planners and foresters have been working to minimize the insect's impact through strategies including insecticidal tree injections, biological controls which kill the insect and adjusted planting regimes. It is estimated that there are nearly 87,000 ash trees across the city of Chicago with a compensatory value of \$84.2 million. Due to the cost and continued maintenance involved, insecticidal treatments are typically limited to established, high value trees while smaller ash and those growing in natural areas are left untreated and are unable to survive. This reality can be observed in the Chicago data which show that no ash under 5 inches in diameter are present and 43.2 percent of ash in Chicago are 11 inches or greater in diameter. All live ash in Chicago are

located in maintained areas such as yards or mowed medians. Although the treatment reduces insect damage on the treated trees, re-application is required every three years and many trees still show some signs of impact. Green ash was reported to have average crown dieback of 21.7 percent, and an estimated 18,000 standing dead ash are present across the city. As medium and large sized trees located in maintained areas, the remaining live ash continue to provide significant benefits within the city, but the presence of standing dead trees and significant crown dieback on live trees suggests that ash will continue to require extra attention and planning.

Although not included in the list of 45 pest and diseases that were analyzed and summarized in Table 30, spotted lanternfly (*Lycorma delicatula*) is a pest that may impact the Chicago region in the near future. First detected in Pennsylvania in 2014, at the time of this report the nearest detected population is in Switzerland County, Indiana, just over 300 miles from Chicago (IN DNR 2023). The feeding activity of the insect stresses trees by causing wounds that lead to wilting and branch death, leaving the host more susceptible to other pests and diseases (Barringer and Ciafré 2020, IN DNR 2023). Spotted lanternfly has a broad range of hosts including sugar and silver maple, oaks (*Quercus* spp.), walnuts (*Juglans* spp.), cherries and peaches (*Prunus* spp.), pears (*Pyrus* spp.), and more (Barringer and Ciafré 2020). The data from the 2019 inventory suggests that approximately 1.8 million trees would be at risk of damage if the spotted lanternfly became established in Chicago. Nearly one third (30.3 percent) of these host trees are 11 inches or greater in diameter which accounts for 64.1 percent of all the trees of that size in Chicago. As the insect's preferred host species, the presence of ailanthus in Chicago may increase the potential for populations to become established when the insect eventually finds its way to the region (IN DNR 2023, PDA 2023).

CONCLUSIONS



Trees and greenspace are an integral part of the city. Even dwarfed by towering buildings, trees impact residents and visitors by providing cooling shade, removing pollutants from the air, reducing runoff, and providing many benefits which are not quantified in this report. USDA Forest Service photo by Thomas Brandeis.

Chicago's urban forest contributes to the city's environmental, economic, and societal well-being. Throughout the city, an estimated 4.68 million trees, representing 48 species, provide an estimated tree canopy cover of 16.1 percent. These trees provide a wide range of important environmental benefits including air pollution removal, reduced carbon emissions, carbon storage and sequestration, reduced energy use for buildings, stormwater capture, and many others.

There are several forces that may affect Chicago's urban forest structure, health, and environmental benefits provided to the city's residents in the future. These include insect and disease infestations, aging and loss of larger trees, the expansion of invasive species, changes in the management and use of the urban forest, and growth of the human population.



This analysis provides a baseline for future monitoring. While data from this report capture attributes of the current urban forest resource and associated ecosystem services and values, future monitoring will identify how it is changing over time. The plots measured in Chicago will be re-measured annually on a 7-year cycle as part of the continuing Urban FIA program. Future analyses of the city's forest can be used to determine the role that natural and human forces play in shaping urban forest structure and composition.

For now, managers can use the data in this report to inform long-term management plans and policies to sustain a healthy urban tree population and ecosystem services for future generations. Planning and management of the urban forest resource can help sustain vital ecosystem services and values for current and future generations in Chicago. In the future, change analyses can be used to evaluate the success of urban forest management programs.

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GLOSSARY OF TERMS

Diameter: For timber species, diameter is measured at breast height (d.b.h.), which is usually measured at 4.5 feet above the ground line on the uphill side of the tree. For woodland species, if the tree has multiple stems, the diameter of each is taken and combined to establish the total diameter of the tree. Woodland diameters are measured at the ground line or at the stem(s) root collar (d.r.c.), whichever is higher. Timber and woodland tree species are listed in Appendix 2 and woodland species are identified with a superscript “b” following the common name (USDA Forest Service 2018).

Forest/forest land/forested area: Land that has at least 10 percent crown cover by live trees or land formerly having such tree cover and is not currently developed for nonforest use. The minimum area for classification as forest land is 1 acre and 120 feet in width. Unimproved roads and trails, streams and other bodies of water, or natural clearings in forested areas shall be included within surrounding forested conditions if less than 120 feet in width and 1.0 acre in size (<30 feet wide for streams and rivers). Forest land is divided into timberland, reserved forest land, and other forest land (such as woodland) (USDA Forest Service 2016b).

Invasive species: A nonnative species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112, 1999). A list of potential invasive plant species included in this inventory is presented in Appendix 6.

Rights-of-way: Developed lands including improved and/or maintained roads, railways, power or gas line clearings, and maintained canals (USDA Forest Service 2018).

Rotten or cull: Missing or rotten main stem or large branch volume caused by agents including cankers, punky knots, hollow sounding stems, or embedded metal in the wood (USDA Forest Service 2016b, 2018).

Shannon-Wiener diversity index: An index of species diversity (also known as the Shannon diversity index) which takes into account both species richness (total number of species in a community) and species evenness (relative abundances among species in a community). Shannon diversity (H') is calculated as follows:

$$H' = - \sum_{i=1}^S p_i \ln (p_i)$$

where: S = the total number of species in the community (species richness) and p_i = proportion of the total assemblage of individuals represented by individuals of species i (Shannon 1948, Spellerberg and Fedor 2003).

Woodland: A subset of Forest Inventory and Analysis-designated forest land that is dominated by woodland species (Dooley 2019).

Woodland species: Forest Inventory and Analysis classifies all tree species into either woodland or timber categories. Woodland species are typically small, slow-growing trees characterized by a multi-stemmed growth form; timber species generally grow from a single central stem (USDA Forest Service 2018). This difference in typical form induced some differences in data collection and calculation, such as how diameters are determined (see Diameter definition).

APPENDIX 1 – LAND COVER DESCRIPTION

Table 32.—National Land Cover Database (NLCD) land cover descriptions

NLCD land cover class	NLCD code	Land cover description
Open water	11	Areas of open water generally with less than 25 percent of vegetation or soil.
Perennial ice/snow	12	Areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Developed-open space	21	Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
Developed-low intensity	22	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20 percent to 49 percent of total cover. These areas most commonly include single-family housing units.
Developed-medium intensity	23	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50 percent to 79 percent of the total cover. These areas most commonly include single-family housing units.
Developed-high intensity	24	Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80 percent to 100 percent of the total cover.
Barren land (rock/sand/clay)	31	Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Deciduous forest	41	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen forest	42	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed forest	43	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.

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Table 32 (continued).

NLCD land cover class	NLCD code	Land cover description
Dwarf scrub	51	Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
Shrub/Scrub	52	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Grassland/Herbaceous	71	Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Sedge/Herbaceous	72	Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
Lichens	73	Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
Moss	74	Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
Pasture/Hay	81	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
Cultivated crops	82	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Woody wetlands	90	Areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Emergent herbaceous wetlands	95	Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Source: Homer et al. 2015

APPENDIX 2 – TREE SPECIES COMPOSITION

Table 33.—List of all live tree species and their characteristics, Chicago, 2019

Genus	Species	Common name	1-4.9 in. diameter trees (number)	5-10.9 in. diameter trees (number)	11+ in. diameter trees (number)	Total (number)	Total (percent)	Total SE (number)	Average diameter (in.)
<i>Acer</i>	<i>negundo</i>	boxelder	143,000	94,000	19,000	257,000	5.5	201,000	5.8
<i>Acer</i>	<i>platanooides</i>	Norway maple ^a	60,000	30,000	143,000	232,000	5.0	73,000	12.6
<i>Acer</i>	<i>rubrum</i>	red maple	0	4,700	4,700	9,500	0.2	7,000	8.3
<i>Acer</i>	<i>saccharinum</i>	silver maple	60,000	14,000	149,000	223,000	4.8	80,000	18.3
<i>Acer</i>	<i>x freemanii</i>	Freeman maple	0	5,800	15,000	21,000	0.5	13,000	11.1
<i>Ailanthus</i>	<i>altissima</i>	ailanthus	0	29,000	24,000	53,000	1.1	29,000	11.9
<i>Carya</i>	<i>ovata</i>	shagbark hickory	0	5,800	0	5,800	0.1	5,600	6.3
<i>Catalpa</i>	<i>speciosa</i>	northern catalpa	0	9,500	4,700	14,000	0.3	11,000	9.4
<i>Catalpa</i>	spp.	catalpa spp.	0	4,700	0	4,700	0.1	5,000	10.3
<i>Celtis</i>	<i>occidentalis</i>	hackberry	60,000	15,000	27,000	102,000	2.2	65,000	6.3
<i>Cercis</i>	<i>canadensis</i>	eastern redbud	0	26,000	0	26,000	0.6	26,000	6.3
<i>Cornus</i>	spp.	dogwood spp.	0	4,700	0	4,700	0.1	5,000	7.9
<i>Corylus</i>	<i>colurna</i>	Turkish hazelnut	0	5,200	0	5,200	0.1	5,100	8.8
<i>Elaeagnus</i>	<i>angustifolia</i>	Russian-olive	0	4,700	0	4,700	0.1	5,000	6.3
<i>Fraxinus</i>	<i>americana</i>	white ash	0	0	16,000	16,000	0.4	9,300	20.9
<i>Fraxinus</i>	<i>pennsylvanica</i>	green ash	0	49,000	21,000	70,000	1.5	24,000	10.0
<i>Ginkgo</i>	<i>biloba</i>	ginkgo, maidenhair tree	0	0	4,700	4,700	0.1	5,000	15.2
<i>Gleditsia</i>	<i>triacanthos</i>	honeylocust	0	32,000	70,000	102,000	2.2	30,000	15.5
<i>Juglans</i>	<i>nigra</i>	black walnut	0	11,000	4,700	15,000	0.3	9,000	9.4
<i>Juniperus</i>	<i>virginiana</i>	eastern redcedar	0	0	5,800	5,800	0.1	5,600	12.1
<i>Malus</i>	spp.	apple spp.	0	4,700	0	4,700	0.1	5,000	6.1
<i>Morus</i>	<i>alba</i>	white mulberry	538,000	5,200	69,000	612,000	13.1	337,000	4.1
<i>Morus</i>	<i>rubra</i>	red mulberry	0	5,800	0	5,800	0.1	5,600	7.4
<i>Picea</i>	<i>abies</i>	Norway spruce	0	0	14,000	14,000	0.3	15,000	17.9
<i>Picea</i>	<i>rubens</i>	red spruce	0	4,700	0	4,700	0.1	5,000	7.4
<i>Pinus</i>	<i>strobus</i>	eastern white pine	0	5,200	9,500	15,000	0.3	8,700	13.8
<i>Platanus</i>	<i>hybrida</i>	London planetree	0	0	11,000	11,000	0.2	7,500	18.2
<i>Populus</i>	<i>deltoides</i>	eastern cottonwood	0	26,000	88,000	114,000	2.4	53,000	20.7

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Table 33 (continued).

Genus	Species	Common name	1-4.9 in. diameter trees (number)	5-10.9 in. diameter trees (number)	11+ in. diameter trees (number)	Total (number)	Total (percent)	Total SE (number)	Average diameter (in.)
<i>Prunus</i>	<i>persica</i>	peach	143,000	5,800	0	149,000	3.2	143,000	1.3
<i>Prunus</i>	<i>serotina</i>	black cherry	0	35,000	23,000	58,000	1.2	42,000	10.1
<i>Prunus</i>	<i>x yedoensis</i>	Yoshino flowering cherry	0	0	4,700	4,700	0.1	5,000	14.8
<i>Pyrus</i>	<i>calleryana</i>	Callery pear	0	9,500	0	9,500	0.2	7,000	10
<i>Quercus</i>	<i>macrocarpa</i>	bur oak	0	0	12,000	12,000	0.2	11,000	30.7
<i>Quercus</i>	<i>palustris</i>	pin oak	0	5,800	0	5,800	0.1	5,600	6.1
<i>Quercus</i>	<i>rubra</i>	northern red oak	0	0	17,000	17,000	0.4	12,000	20.8
<i>Quercus</i>	<i>velutina</i>	black oak	0	12,000	29,000	41,000	0.9	39,000	17.7
<i>Rhamnus</i>	<i>cathartica</i>	common buckthorn ^a	1,900,000	46,000	0	1,940,000	41.5	1,410,000	2.0
<i>Taxodium</i>	<i>distichum</i>	baldcypress	0	0	4,700	4,700	0.1	5,000	14.2
<i>Thuja</i>	<i>plicata</i>	western red cedar	0	4,700	0	4,700	0.1	5,000	5.2
<i>Tilia</i>	<i>americana</i>	American basswood	0	25,000	16,000	41,000	0.9	19,000	11.1
<i>Tilia</i>	<i>cordata</i>	littleleaf linden	0	15,000	19,000	34,000	0.7	16,000	13.9
<i>Ulmus</i>	<i>americana</i>	American elm	60,000	5,800	10,000	75,000	1.6	64,000	5.4
<i>Ulmus</i>	<i>parvifolia</i>	Chinese elm	0	4,700	0	4,700	0.1	5,000	7.1
<i>Ulmus</i>	<i>pumila</i>	Siberian elm ^a	262,000	27,000	17,000	307,000	6.6	212,000	2.8
<i>Ulmus</i>	<i>rubra</i>	slippery elm	0	11,000	0	11,000	0.2	7,500	9.8
Total			3,220,000	602,000	855,000	4,680,000	100	1,670,000	6.0

Due to rounding, not all values will add up exactly.

Diameter measurements were taken at breast height (d.b.h.) or root collar (d.r.c.) for woodland species.

Median and average diameter measurements are estimated for live trees only.

^a Invasive species.

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APPENDIX 3 – TREE CHARACTERISTICS WITHIN NLCD LAND COVER CLASSES AND FIA LAND USE

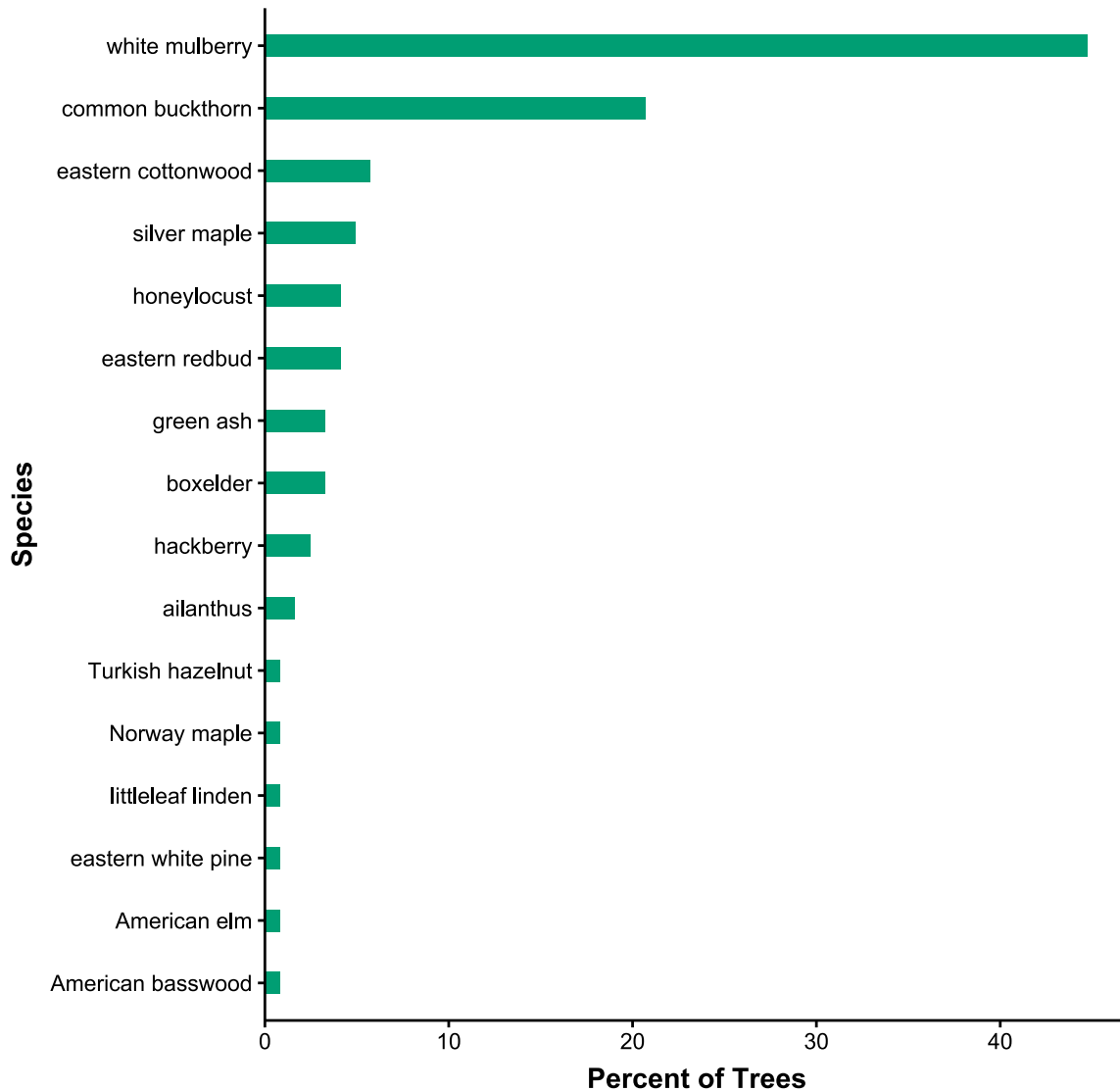


Figure 27.—Percent of trees within developed-high land cover class, Chicago, 2019.

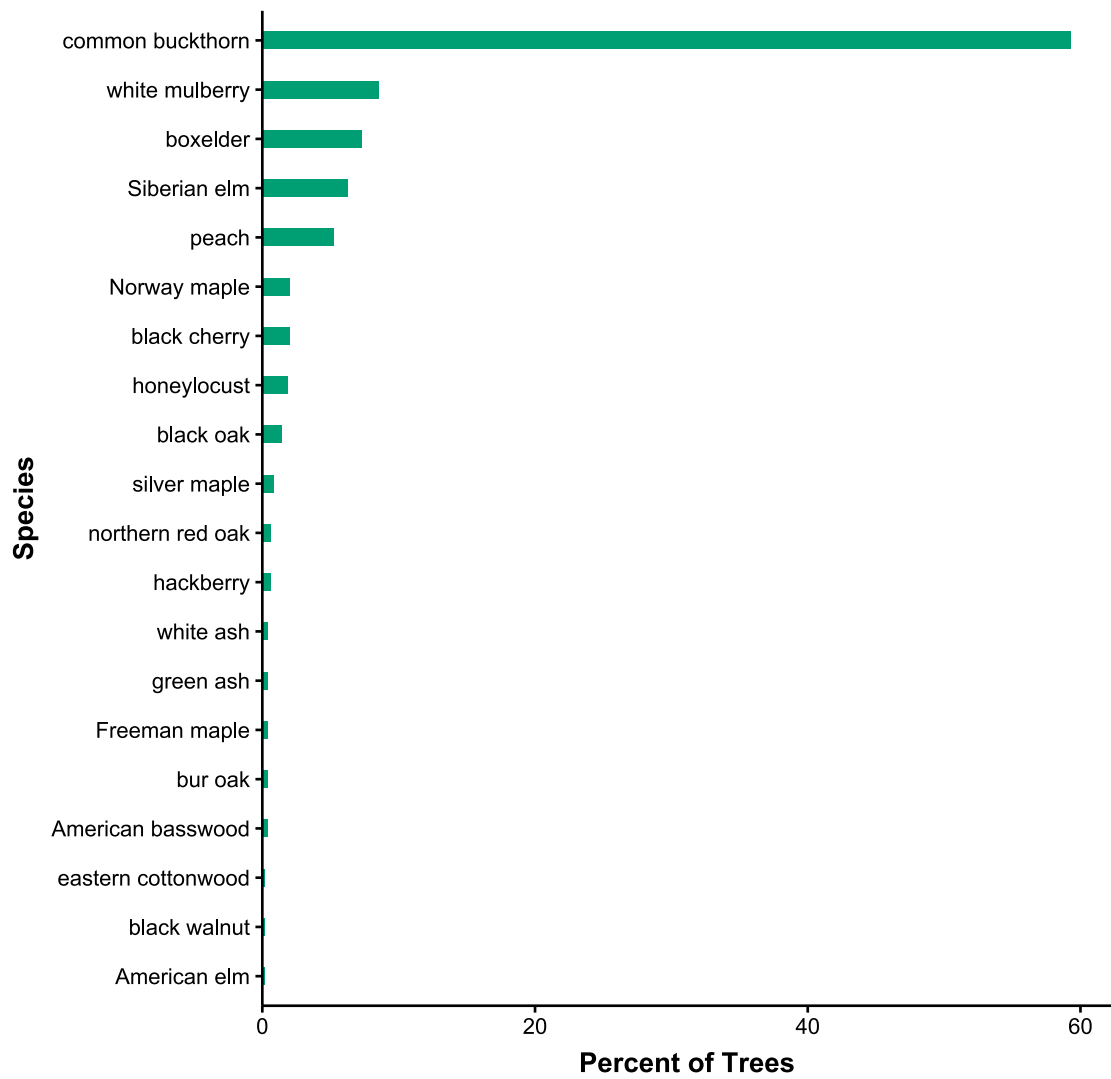


Figure 28.—Percent of total trees within developed-low land cover class, Chicago, 2019.

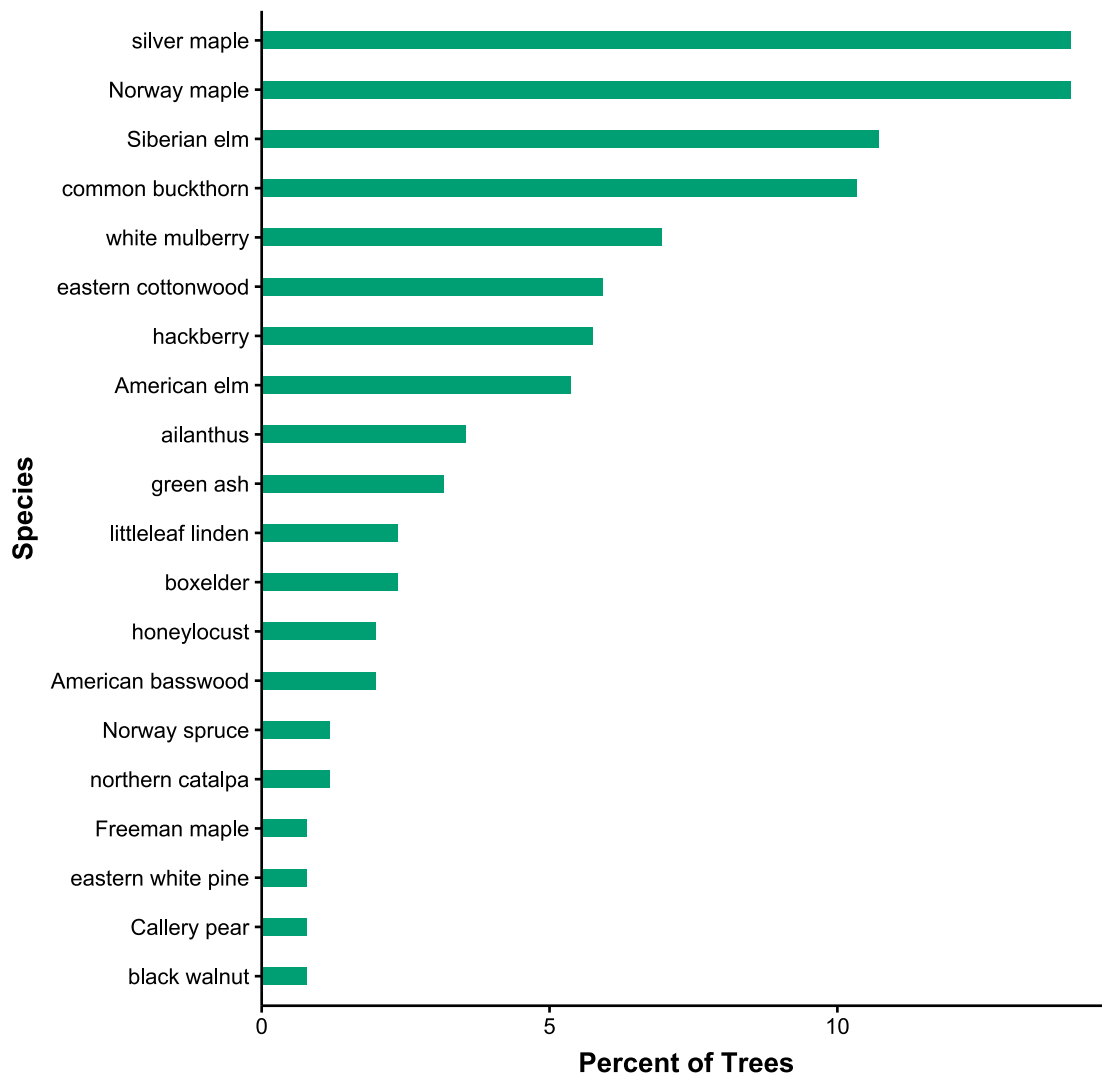


Figure 29.—Percent of total trees within the developed-medium land cover class, Chicago, 2019.

Table 34.—Tree statistics by National Land Cover Database (NLCD) land cover class, extrapolated to sampling area scale from plot inventory, Chicago, 2019

Land cover	Common name	Trees (number)	Basal area ^a (sq ft per ac)	Average diameter ^b (inches)
Developed-high	American basswood	5,234	0.8	12.1
	American elm	5,234	1	13.7
	Norway maple ^c	5,234	3.7	26
	Turkish hazelnut	5,234	0.4	8.8
	ailanthus	10,468	1.5	14.9
	boxelder	20,936	0.6	10.2
	common buckthorn ^c	132,050	0	1.1
	eastern cottonwood	36,638	0.9	12
	eastern redbud	26,170	0.2	6.3
	eastern white pine	5,234	0.5	9.2
	green ash	20,936	0.4	8.2
	hackberry	15,702	1	13.5
	honeylocust	26,170	0.9	11.8
	littleleaf linden	5,234	0.6	10.5
	silver maple	31,404	2.7	21.2
	white mulberry	285,036	0.1	2.2
Developed-low/vegetated	American basswood	11,647	0.7	10.4
	American elm	5,824	0.5	9.3
	Freeman maple	11,647	0.5	9.2
	London planetree	5,824	2.7	22.3
	Norway maple ^c	58,235	1.6	16.6
	Siberian elm ^c	178,029	0.2	3.6
	black cherry	58,235	0.6	10.1
	black oak	40,765	2.1	17.7
	black walnut	5,824	0.2	5.6
	boxelder	207,146	0.1	4.6
	bur oak	11,647	5.2	30.7
	common buckthorn ^c	1,686,273	0	2.1
	eastern cottonwood	5,824	7.8	37.8
	eastern red cedar	5,824	0.8	12.1
	green ash	11,647	1.5	16.2
	hackberry	17,471	1.6	15.2
	honeylocust	52,412	1.7	16.3
	northern red oak	17,471	2.5	20.8
	peach	148,911	0	1.3

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Table 34 (continued).

Land cover	Common name	Trees (number)	Basal area ^a (sq ft per ac)	Average diameter ^b (inches)
Developed-low/vegetated (cont.)	pin oak	5,824	0.2	6.1
	red mulberry	5,824	0.3	7.4
	shagbark hickory	5,824	0.2	6.3
	silver maple	23,294	7.2	35.1
	slippery elm	5,824	0.5	9.9
	white ash	11,647	2.5	20.0
	white mulberry	243,749	0.4	5.0
Developed-medium	American basswood	23,691	1.0	11.3
	American elm	64,365	0.2	4.4
	Callery pear	9,476	0.5	10.0
	Chinese elm	4,738	0.3	7.1
	Freeman maple	9,476	1.0	13.3
	London planetree	4,738	1.0	13.2
	Norway maple ^c	168,604	0.9	10.8
	Norway spruce	14,214	1.8	17.9
	Russian-olive	4,738	0.2	6.3
	Siberian elm ^c	128,729	0.0	1.8
	Yoshino flowering cherry	4,738	1.2	14.8
	ailanthus	42,643	0.8	11.1
	apple spp.	4,738	0.2	6.1
	baldcypress	4,738	1.1	14.2
	black walnut	9,476	0.8	11.8
	boxelder	28,429	0.9	12.0
	catalpa spp.	4,738	0.6	10.3
	common buckthorn ^c	123,991	0.0	2.5
	dogwood spp.	4,738	0.3	7.9
	eastern cottonwood	71,072	3.5	23.8
	eastern white pine	9,476	1.6	16.4
	ginkgo, maidenhair tree	4,738	1.3	15.2
	green ash	37,905	0.5	9.1
	hackberry	69,103	0.1	2.5
	honeylocust	23,691	1.9	17.7
	littleleaf linden	28,429	1.3	14.5
	northern catalpa	14,214	0.6	9.4
	red maple	9,476	0.4	8.3

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Table 34 (continued).

Land cover	Common name	Trees (number)	Basal area ^a (sq ft per ac)	Average diameter ^b (inches)
Developed-medium (<i>cont.</i>)	red spruce	4,738	0.3	7.4
	silver maple	168,604	2.2	15.4
	slippery elm	4,738	0.5	9.7
	western red cedar	4,738	0.1	5.2
	white ash	4,738	3.0	23.4
	white mulberry	83,317	0.7	7.8

^a Basal area is the cross-sectional area of the tree stems measured at the diameter.

^b Diameter measurements were taken at breast height (d.b.h.) or root collar (d.r.c.) for woodland species.

^c Invasive species.

Table 35.—Estimates of total number of trees, basal area, and average diameter by Forest Inventory and Analysis (FIA) land use, Portland, Chicago, 2019

Land use	Common name	Trees (number)	Basal area ^a (sq ft per ac)	Average diameter ^b (inches)
Forest land	American basswood	5,824	0.1	5.1
	ailanthus	23,691	0.8	10.5
	black cherry	58,235	0.6	10.1
	black oak	40,765	2.1	17.7
	boxelder	207,146	0.1	4.6
	bur oak	11,647	5.2	30.7
	common buckthorn ^c	1,810,265	0.0	2.1
	eastern cottonwood	33,167	2.1	18.7
	hackberry	71,274	0.1	2.8
	northern red oak	17,471	2.5	20.8
	pin oak	5,824	0.2	6.1
	shagbark hickory	5,824	0.2	6.3
	slippery elm	5,824	0.5	9.9
	white mulberry	4,738	1.5	16.8
	white mulberry	5,824	7.1	36.1
Agriculture	American basswood	18,953	0.3	7.4
	Norway maple ^c	14,710	3.0	23.2
	Russian-olive	4,738	0.2	6.3
	Siberian elmc	4,738	0.6	10.2
	ailanthus	10,468	1.5	14.9
	common buckthorn ^c	132,050	0.0	1.1
	eastern cottonwood	50,853	1.5	15
	littleleaf linden	14,710	0.4	8.2
	northern catalpa	4,738	1.2	15.1
	white mulberry	264,100	0.0	1.4
Commercial/Industrial	American basswood	5,234	0.8	12.1
	Callery pear	4,738	0.5	9.6
	Norway maple ^c	4,738	0.3	7.1
	boxelder	20,936	0.6	10.2
	eastern white pine	5,234	0.5	9.2
	green ash	4,738	0.2	5.3
	white mulberry	9,476	1.8	17.9
Multi-family residential	American elm	11,058	0.7	11.4
	London planetree	5,824	2.7	22.3
	Norway maple ^c	11,647	1.6	17.2
Residential	American elm	11,058	0.7	11.4
	London planetree	5,824	2.7	22.3
	Norway maple ^c	11,647	1.6	17.2

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Table 35 (continued).

Land use	Common name	Trees (number)	Basal area ^a (sq ft per ac)	Average diameter ^b (inches)
Residential (<i>cont.</i>)	Siberian elm ^c	119,253	0.0	1.3
	Yoshino flowering cherry	4,738	1.2	14.8
	ailanthus	14,214	1.0	13.3
	black walnut	15,300	0.6	9.4
	boxelder	28,429	0.9	12.0
	catalpa spp.	4,738	0.6	10.3
	eastern cottonwood	23,691	5.6	31.5
	eastern redcedar	5,824	0.8	12.1
	eastern white pine	9,476	1.6	16.4
	green ash	5,824	1.9	18.9
	hackberry	4,738	0.3	8.0
	honeylocust	5,824	4.2	27.8
	peach	148,911	0.0	1.3
	red mulberry	5,824	0.3	7.4
	red spruce	4,738	0.3	7.4
	silver maple	79,665	1.0	6.5
	western red cedar	4,738	0.1	5.2
	white ash	5,824	4.1	27.4
	white mulberry	102,772	0.6	7.8
Recreation/Cemetery	Norway maple ^c	5,824	1.0	13.7
	Siberian elm ^c	178,029	0.2	3.6
	dogwood spp.	4,738	0.3	7.9
	eastern redbud	26,170	0.2	6.3
	hackberry	5,234	1.0	13.2
	honeylocust	11,647	0.9	11.4
	littleleaf linden	9,476	2.1	19.5
	silver maple	5,234	5.4	31.4
	white mulberry	214,632	0.0	2.5
Rights-of-way	American basswood	10,562	2.5	20.6
	American elm	64,365	0.2	4.4
	Callery pear	4,738	0.6	10.4
	Chinese elm	4,738	0.3	7.1
	Freeman maple	21,123	0.7	11.1
	London planetree	4,738	1.0	13.2
	Norway maple ^c	195,154	1.0	11.7

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Table 35 (continued).

Land use	Common name	Trees (number)	Basal area ^a (sq ft per ac)	Average diameter ^b (inches)
Rights-of-way (<i>cont.</i>)	Norway spruce	14,214	1.8	17.9
	Siberian elm ^c	4,738	0.1	5.1
	Turkish hazelnut	5,234	0.4	8.8
	ailanthus	4,738	0.4	8.1
	apple spp.	4,738	0.2	6.1
	baldcypress	4,738	1.1	14.2
	eastern cottonwood	5,824	7.8	37.8
	ginkgo, maidenhair tree	4,738	1.3	15.2
	green ash	59,927	0.5	9.5
	hackberry	21,030	1.7	16.3
	honeylocust	84,802	1.4	15.2
	littleleaf linden	9,476	1.6	17.0
	northern catalpa	9,476	0.2	6.5
	red maple	9,476	0.4	8.3
	silver maple	138,404	3.8	24.6
	slippery elm	4,738	0.5	9.7
	white ash	10,562	1.8	17.4
	white mulberry	10,562	5.0	30.0

Due to rounding, not all values will add up exactly.

^a Basal area is the cross-sectional area of the tree stems measured at the diameter.

^b Diameter measurements were taken at breast height (d.b.h.) or root collar (d.r.c.) for woodland species.

^c Invasive species.

APPENDIX 4 – SPECIES COMPOSITION IN MAINTAINED AREAS

Table 36.—Species composition in maintained areas, Chicago, 2019

Common name	Number of trees	Common name	Number of trees
Norway maple	232,000	northern catalpa	14,000
silver maple	223,000	London planetree	11,000
peach	149,000	red maple	9,500
Siberian elm	129,000	black walnut	9,500
white mulberry	129,000	Callery pear	9,500
honeylocust	91,000	eastern redcedar	5,800
American elm	75,000	red mulberry	5,800
green ash	70,000	Turkish hazelnut	5,200
boxelder	49,000	red spruce	4,700
American basswood	35,000	baldcypress	4,700
littleleaf linden	34,000	western redcedar	4,700
hackberry	31,000	catalpa spp.	4,700
eastern cottonwood	30,000	dogwood spp.	4,700
eastern redbud	26,000	ginkgo, maidenhair tree	4,700
ailanthus	25,000	apple spp.	4,700
Freeman maple	21,000	slippery elm	4,700
white ash	16,000	Yoshino flowering cherry	4,700
eastern white pine	15,000	Chinese elm	4,700
Norway spruce	14,000		

APPENDIX 5 – DAMAGE, MAINTENANCE AND SITE ISSUES BY SPECIES

Table 37.—Percent of live trees identified with damage, maintenance and site issues in Chicago, 2019

Species	Sample (n)	Excess mulch (percent)	Root/stem girdling (percent)	Bark inclusion (percent)	Topping/pruning (percent)	Root conflict (percent)	Crown conflict (percent)	Improper planting (percent)
American basswood	8	11.7	0.0	24.6	14.4	0.0	0.0	0.0
American elm	4	0.0	0.0	14.7	0.0	13.2	6.9	6.9
Callery pear	2	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Freeman maple	4	0.0	27.6	27.6	44.9	22.4	0.0	27.6
Norway maple	35	0.0	0.0	13.2	8.6	6.8	2.5	10.4
Siberian elm	12	1.5	0.0	38.9	0.0	0.0	0.0	3.8
Turkish hazelnut	1	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Yoshino flowering cherry	1	0.0	0.0	0.0	0.0	0.0	100.0	100.0
ailanthus	11	0.0	0.0	26.8	0.0	8.9	8.9	0.0
apple spp.	1	0.0	0.0	100.0	0.0	0.0	0.0	0.0
baldcypress	1	0.0	0.0	0.0	0.0	100.0	100.0	0.0
black walnut	3	0.0	0.0	69.0	0.0	0.0	0.0	0.0
boxelder	23	0.0	0.0	7.4	0.0	0.0	0.0	3.7
common buckthorn	35	0.0	0.0	0.0	0.0	0.0	3.7	1.2
dogwood spp.	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0
eastern cottonwood	23	0.0	0.0	21.3	0.0	9.7	8.3	4.2
eastern redbud	5	0.0	0.0	0.0	0.0	0.0	0.0	80.0
eastern redcedar	1	0.0	0.0	100.0	0.0	0.0	100.0	0.0
eastern white pine	3	0	0.0	35.6	0.0	0.0	0.0	0.0
ginkgo, maidenhair tree	1	0.0	0.0	100.0	0.0	0.0	0.0	100.0
green ash	14	0.0	7.4	23.1	0.0	7.4	6.7	7.4
hackberry	9	0.0	0.0	14.9	0.0	10.2	0.0	4.6
honeylocust	19	5.1	0.0	21.6	0.0	0.0	5.7	0.0
littleleaf linden	7	0.0	0.0	15.5	0.0	28.2	15.5	42.2
peach	3	0.0	0.0	3.9	0.0	0.0	0.0	3.9
red maple	2	0.0	0.0	50.0	0.0	0.0	0.0	0.0
red mulberry	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0
silver maple	34	0.0	0.0	30.6	0.0	5.0	0.0	8.9
western redcedar	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0
white ash	3	0.0	0.0	35.5	0.0	0.0	0.0	0.0
white mulberry	22	0.0	0.0	9.5	0.0	1.9	34.0	14.2

APPENDIX 6 – LIST OF INVASIVE PLANT SPECIES

Table 38.—Invasive plant species monitored during the inventory of Chicago, 2019

Scientific Name	Common name	Scientific Name	Common name
<i>Acer platanoides</i>	Norway maple	<i>Lonicera</i>	honeysuckle
<i>Ailanthus altissima</i>	ailanthus	<i>Lonicera tatarica</i>	Tatarian honeysuckle
<i>Albizia julibrissin</i>	mimosa, silktree	<i>Lysimachia nummularia</i>	creeping jenny
<i>Alliaria petiolata</i>	garlic mustard	<i>Lythrum salicaria</i>	purple loosestrife
<i>Berberis thunbergii</i>	Japanese barberry	<i>Melia azedarach</i>	chinaberry
<i>Berberis vulgaris</i>	common barberry	<i>Melaleuca quinquenervia</i>	melaleuca
<i>Celastrus orbiculatus</i>	Oriental bittersweet	<i>Microstegium vimineum</i>	Nepalese browntop
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	<i>Phalaris arundinacea</i>	reed canarygrass
<i>Cirsium arvense</i>	Canada thistle	<i>Phragmites australis</i>	common reed
<i>Cirsium vulgare</i>	bull thistle	<i>Polygonum cuspidatum</i>	Japanese knotweed
<i>Cynanchum louiseae</i>	Louise's swallow-wort	<i>Polygonum sachalinense</i>	giant knotweed
<i>Cynanchum rossicum</i>	European swallow-wort	<i>Rhamnus cathartica</i>	common buckthorn
<i>Elaeagnus angustifolia</i>	Russian-olive	<i>Rosa multiflora</i>	multiflora rose
<i>Elaeagnus umbellata</i>	autumn olive	<i>Robinia pseudoacacia</i>	black locust
<i>Euphorbia esula</i>	leafy spurge	<i>Spiraea japonica</i>	Japanese meadowsweet
<i>Frangula alnus</i>	glossy buckthorn	<i>Tamarix ramosissima</i>	saltcedar
<i>Hedera helix</i>	English ivy	<i>Triadica sebifera</i>	Chinese tallowtree
<i>Hesperis matronalis</i>	dames rocket	<i>Ulmus pumila</i>	Siberian elm
<i>Ligustrum vulgare</i>	European privet	<i>Viburnum opulus</i>	European cranberrybush
<i>Lonicera x bella</i>	showy fly honeysuckle	<i>Lonicera maackii</i>	Amur honeysuckle
<i>Lonicera japonica</i>	Japanese honeysuckle	<i>Paulownia tomentosa</i>	paulownia, empress-tree
<i>Lonicera morrowii</i>	Morrow's honeysuckle	<i>Polygonum x bohemicum</i>	Bohemian knotweed

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