CONSERVING TREES AND FORESTS IN METROPOLITAN WASHINGTON

Report on the state of the region's tree canopy and its benefits, the development of new regional goals, and strategies for action at the local level

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Metropolitan Washington
Council of Governments

CONSERVING TREES AND FORESTS IN METROPOLITAN WASHINGTON

Prepared by the COG Regional Tree Canopy Subcommittee for the COG Climate, Energy, and Environment Policy Committee
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ABOUT COG

The Metropolitan Washington Council of Governments (COG) is an independent, nonprofit association that brings area leaders together to address major regional issues in the District of Columbia, suburban Maryland, and Northern Virginia. COG's membership is comprised of 300 elected officials from 24 local governments, the Maryland and Virginia state legislatures, and U.S. Congress.

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EXECUTIVE SUMMARY

In February 2019, the COG Board of Directors endorsed the establishment of a Regional Tree Canopy Subcommittee (RTCS) of the COG Climate, Energy, and Environment Policy Committee (CEEPC) charged "with protecting, managing, and expanding urban forestry assets for health and quality of life; optimizing urban forest programs; developing a regional urban forest action plan and canopy goals; inspiring the community to take ownership of efforts to protect and expand urban forests; and integrating urban forestry with Region Forward [COG's regional vision plan]..." (Resolution R7-2019). This action followed a recommendation contained in the *Tree Canopy Management Strategy* published in May 2018 establishing an ongoing forest policy committee to, in part, develop a regional tree action plan and regional tree canopy goals.

In response to this direction, RTCS has prepared a three-part report to encourage member jurisdictions to strengthen local tree conservation programs and to act collaboratively on matters relating to the protection and management of tree and forest assets to enhance the quality of life, well-being, and natural environment enjoyed by our residents and visitors. Most notably, the report recommends that area leaders adopt a regional tree canopy goal to encourage and assist COG member jurisdictions in monitoring, protecting, and managing their local trees and forests, and where feasible, to coordinate regionally to conserve our tree canopy.

The report outlines various benefits and services offered by tree canopy as well as discussions on recognizing and managing tree risks and costs and the need to monitor and mitigate threats to trees and forests.

Part 1: A Case for Conserving Trees and Forests in the Metropolitan Washington Region

This section presents ten incentives for why COG jurisdictions should take action to increase their local tree conservation and management efforts, including how tree canopy enhances human health and quality of life, helps address environmental equity, builds cohesive neighborhoods, and reduces crime, grows healthy economies, and mitigates climate change/strengthens climate resilience.

Part 2: Tree Canopy Goals for the Metropolitan Washington Region

This section delves into the three tiers of goals for area jurisdictions: one overarching goal for the metropolitan Washington region, intermediate goals based on population density and urbanization, and smaller scale target goals for general land use categories.

According to Chesapeake Bay Program data, tree canopy covered 51.3 percent of metropolitan Washington (2,213,976 acres) in 2014 and 50.6 percent in 2018. The latest estimate of tree canopy coverage for the region was 49.6 percent in 2023. Regional tree canopy loss detected between 2014 and 2018 was 17,133 acres, or an average of 4,383 acres of tree canopy lost each year. Assuming this trend continued until 2050, the total area of canopy loss for the region would equal about 120,000 acres over an almost three-decade period, meaning its tree canopy coverage would drop to 44.4 percent.

Tree Canopy Gain/Loss within the Metropolitan Washington Council of Governments Member Jurisdictions between 2014 and 2018

	Jurisdiction	Total Acreage of Jurisdiction w/o bodies of water#	Acres of Tree Canopy 2014	Acres of Tree Canopy 2018	% Tree Cover 2014	% Tree Cover 2018	Acres of Tree Canopy Gain/Loss
1	Arlington County, Virginia	16,638.28	5,647.7	5,655.3	33.9%	34.0%	7.6
2	Charles County, Maryland	292,971.63	198,908.4	198,119.6	67.9%	67.6%	788.9
3	Fairfax County, Virginia	250,252.38	140,120.1	139,299.2	56.0%	55.7%	821.0
4	Frederick County, Maryland	422,776.31	179,592.1	181,709.0	42.5%	43.0%	2,116.8
5	Loudoun County, Virginia	330,071.15	147,938.1	145,075.4	44.8%	44.0%	2,862.7
6	Montgomery County, Maryland	315,589.05	153,264.0	147,479.5	48.6%	46.7%	5,784.4
7	Prince George's County, Maryland	308,890.48	168,099.1	160,808.4	54.4%	52.1%	7,290.7
8	Prince William County, Virginia	214,563.21	122,543.7	121,310.1	57.1%	56.5%	1,233.6
9	City of Alexandria, Virginia	9,558.58	2,639.3	2,658.1	27.6%	27.8%	18.8
10*	District of Columbia	39,120.61	15,235.8	14,760.3	38.9%	37.7%	475.5
11	City of Fairfax, Virginia	3,993.88	1,636.5	1,626.6	41.0%	40.7%	9.9
12	City of Falls Church, Virginia	1,309.72	541.1	536.4	41.3%	41.0%	4.6
13	City of Manassas, Virginia	6,299.49	1,502.4	1,498.9	23.8%	23.8%	3.5
14	City of Manassas Park, Virginia	1,941.63	426.0	424.6	21.9%	21.9%	1.4

Source: 2013/2014 and 2017/2018 CBP LULC tree canopy data published in 2022.
Jurisdiction acreage w/o bodies of water data from Census Tiger Data
* Independent Canopy Analysis using 2020 data by PlanIT Geo LLC in 2021

The report recommends three tiers of goals for area jurisdictions:

1. Overarching goal: **The COG Regional Tree Canopy Subcommittee recommends adopting a goal of ensuring at least 50 percent tree canopy coverage for the entire region through 2050**. (See Part 2: Section 1)
2. Intermediate Goals based on Population Density and Urbanization: These goals are provided to help communities identify tree canopy goals for watersheds, planning districts, census tracts, and towns and smaller cities. (See Part 2: Section 4)
3. Smaller Scale Target Goals for General Land Use Categories: These target goals identify mature canopy coverage levels that associated with 18 general classes of land use categories encountered in the COG region. (See Part 2: Section 5)

RTCS recommends that the regional goal and supporting target goals be viewed as fluid and reevaluated once every five years to allow reaction to changing conditions and unforeseeable events. The report goes on to examine how area jurisdictions can support the tree canopy goals through strategies and actions in concert with ones already being implemented. The subcommittee also considered three scenarios to project possible levels of tree canopy coverage between 2022 and 2050 and calculated the value of tree canopy in relation to its air quality, stormwater reduction, and carbon sequestration services, amounting to millions of dollars of benefits each year.

Environmental Services and Benefits Associated with a 10% loss of Existing Canopy

	Annual Air Pollution Removal in LBS	Gallons of Stormwater Runoff Reduced Annually	Tons of Carbon Sequestered Annually
Service	7,983,710/year	616,171,576/year	141,842 tons/year
Monetary Benefit	$9,643,014/year	$5,579,099/year	$26,569,310 tons/year
Accumulated Service over 29-years	231,527,592 lbs.	17,868,975,699 gallons	3,546,051 tons
Monetary Benefit over 29-years	$279,647,415	$161,793,881	$770,510,000

Source: Understanding Your Canopy. Chesapeake Tree Canopy Network. Services and monetary benefits extrapolated from 2018 tree cover data using iTree Landscape software. https://chesapeaketrees.net/understand-your-canopy/

Part 3: Identifying the Right Level of Tree Canopy for Your Community

This section is designed to provide a roadmap to help local governments periodically assess the extent and quality of their trees and forests and to use that information to set overarching goals and objectives to guide efforts to sustain those resources.

David Mark/Pixabay

The report offers 10 steps to provide processes and tools that COG jurisdictions can use to identify achievable canopy goals that balance a wide range of socioeconomic, environmental, and ecological concerns. The subcommittee will serve as the entity to monitor regional progress on the tree canopy goals and update its policy committee and other relevant COG committees on a regular basis going forward.

FOREWARD

Over four decades of peer-reviewed research clearly demonstrates that trees and forests should be regarded as an indispensable component of public infrastructure. These natural resources provide a wide range of services to COG member jurisdictions. They improve environmental quality and ecological health by improving air and water quality, reducing stormwater runoff, sequestering and storing carbon dioxide, moderating ambient air and surface temperatures in urban spaces, providing habitat and food for wildlife, and more. In addition, more recent research has demonstrated the positive relationships between urban trees and human health, safe and inviting communities, and vibrant economies.

Monitoring the extent and attributes of any resource is essential to managing it effectively. Our regional tree canopy is no exception. We must continue to monitor how our trees and forests are changing in reaction to natural and man-made pressures, and to implement both local and regional strategies to conserve these resources so they can sustain their delivery of important services and benefits. This report provides a roadmap to help local governments to periodically evaluate the extent and quality of their trees and forests. The recommendations are presented in three geographic tiers that range from individual parcels to intermediate-sized areas such as planning districts and watersheds, to the entire COG region.

The goals recommended in this report were generated over a four-year period by members of COG's Regional Tree Canopy Subcommittee (RTCS). The process used to generate these recommendations blend empirical data gathered by local urban foresters with data derived from regional land cover/land use data provided by the Chesapeake Conservancy and partners. RTCS is reasonably confident that the goals recommended in this report are realistic and achievable; however, forecasting how tree canopy levels will be impacted by multiple factors that include the effects of climate change on native plant communities; social trends; economic patterns; housing and transportation needs; and the relative effectiveness of laws and ordinances is difficult at best.

The accuracy of the recommended percentages of canopy coverage may ultimately prove less valuable than their capacity to periodically refresh tree conservation as a consideration in ongoing planning and policy making discussions. This could prove especially true if we build in an expectation to reexamine and, if necessary, realign the goals at predefined intervals based on future conditions. **Consequently, we recommend that the three tiers of canopy goals described in this report be treated as fluid and subject to periodic evaluation** (every five years) to allow for adaptation to changing conditions, regional needs, and unforeseeable events.

It should be noted that a substantial number of COG jurisdictions have already adopted tree canopy goals and tree conservation programs at local levels (see Appendix). We anticipate that current events regarding climate change, extreme temperatures, environmental inequity, and unprecedented levels of species extinction on a global basis will prompt even more communities to set local goals and collaborate regionally on matters relating to the protection and management of this key component of our natural systems and infrastructure; one readily found in backyards, along streams, and roads silently delivering important benefits to our families and neighbors, and to which our quality of life, our environmental health, and economies are closely linked.

Regional Tree Canopy Management Subcommittee

PART 1: WHY COG JURISDICTIONS SHOULD INCREASE EFFORTS TO CONSERVE TREES AND FORESTS

The information in this publication is provided to convince policy makers and concerned citizens that efforts to develop and redevelop land and to sustain current levels of human health, quality of life, and economic vitality in the metropolitan Washington region must be accompanied by ongoing efforts to conserve, manage, and expand natural vistas and greenspaces – especially those containing trees and forests.

Although the ability of trees and native forests to improve the quality of water, air, soil and ecological resources is well documented by over four decades of peer-reviewed research, a new body of research is demonstrating how exposure to trees, forests, and other natural features provides substantial mental and physical health benefits to human beings; how urban trees can be used to improve quality of life for everyone that calls the region home; and, how urban trees can help support vibrant local economies.

This publication presents a summary of the benefits and services offered by tree canopy, a discussion concerning why we need to recognize and manage tree risks and costs; and why we need to monitor and mitigate threats to trees and forests. It presents 10 incentives for why COG jurisdictions should take action to increase their local tree conservation and management efforts. The incentives are organized into sections as follows:

1. Exposure to nature is critical to human health and quality of life
2. Urban trees can be used to address environmental equity
3. Trees can be used to build cohesive neighborhoods and reduce crime
4. Trees can be used to increase local retail business and grow healthy economies
5. Trees provide cost-effective solutions and great investments
6. Trees and forests can be used to mitigate climate change
7. Trees can help communities become more climate resilient
8. Trees provide significant levels of environmental and ecological services
9. The need to recognize and manage the costs, damages, and risks associated with trees
10. The need to monitor threats to our regional tree canopy

In addition, the report's appendix cites relevant sources of information and research; and contains weblinks to tree canopy gain/loss information for COG jurisdictions.

Terminology. "Tree canopy" is used in this publication to describe four general classes of land cover defined by a top-down view of the canopy associated with forests, woodlands, and individual trees. These classes were defined by the Chesapeake Bay Program Land Use/Land Cover Project and reflect how tree canopy and areas located underneath tree canopy are detected and classified though the use of high-resolution imagery and remote sensing analyses. (1)

1. **Forest**: All contiguous patches of trees ≥1 acre in extent with a patch width ≥240-ft somewhere in the patch. The understory is assumed to be undisturbed/unmanaged. Includes forests that occur within wetland boundaries.

2. **Tree Canopy over Turf Grass:** Trees within 30-feet of structures or adjacent turf grass and other impervious structure in rural areas and within 60-ft of structures or adjacent turf grass and other impervious in developed areas. The understory in these areas is assumed to be turf grass.

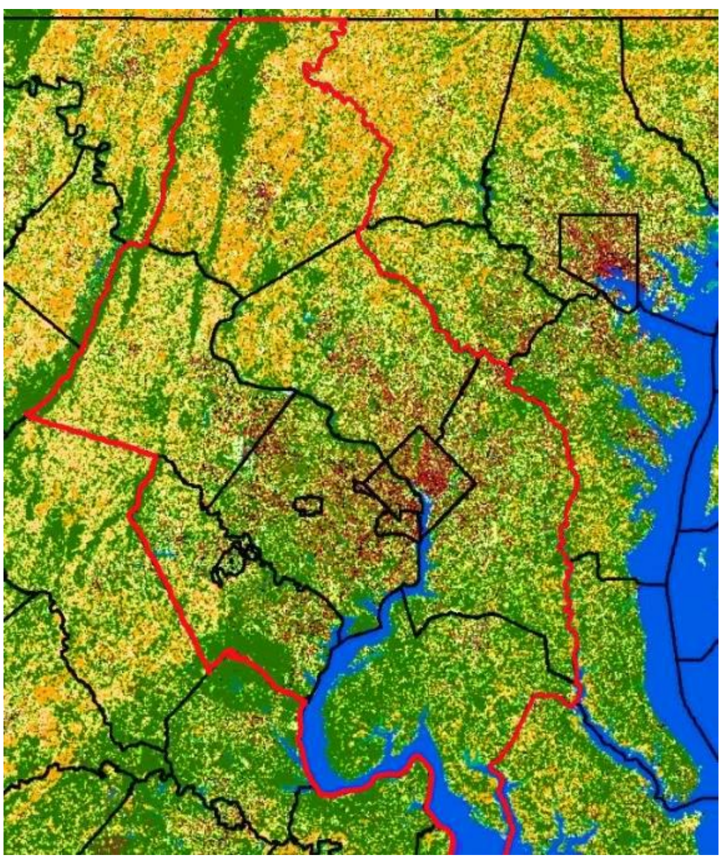
3. **Tree Canopy over Impervious Surfaces:** Tree Cover that overlaps with roads, structures, or other impervious surfaces.

4. **Tree Canopy, Other:** All areas of canopy that do not qualify as "Forest" but are presumed to have an undisturbed/unmanaged understory.

At ground level these four classes represent a variety of native forest and woodland communities or individual trees or groups of trees that have been intentionally planted or grown from seed. They can be comprised of native, naturalized, or invasive tree species and that differ significantly in terms of age, height, crown spread, and trunk diameter.

Over the years, community needs and values have driven state and local governments to establish a variety of tree-related programs with differing missions and objectives. Consequently, terms such as "tree conservation," "urban forestry," "forest management," etc., may be interpreted differently depending on the nature of the trees existing within the jurisdiction and the intent and scope of the programs formulated to manage these. Some programs only provide care for trees on public lands and along streets, while others are focused on enforcing tree regulations during land development processes. Other programs manage trees as just one constituent of plant communities within the context of natural heritage programs. All local programs in our region exist parallel to State Forestry programs which are primarily concerned with promotion of wood products and the conservation of forested lands but may also share conservation and public outreach objectives with local programs.

The intent of this publication is to encourage COG jurisdictions to conserve and manage all classes of tree canopy existing within their boundaries. It is not intended to support the agenda of any one program per se; consequently, the term "tree canopy" is used as a proxy to represent the entire range of landscapes where trees, forests, and woodlands are found. By extension, the term "tree conservation" is used to describe a wide range of goals, strategies, and practices implemented to protect and manage these same features.



The combined landmass of the COG Region
(Chesapeake Bay Program Land Use/Land Cover Project 2022)

Section 1: Exposure to Nature is Critical to Human Health and Quality of Life

Within the last three decades or so, people have been spending less time in natural settings and more time indoors using various electronic devices for work and play. 80 percent of the U.S. population now lives in urban environments [2] where regular exposure to natural settings may be limited at best. This shift is resulting in large numbers of individuals going through daily life effectively alienated from nature.

Limited exposure to natural settings has been described as "*nature-deficit disorder.*" Although a nonclinical term, it has been coined to describe the consequences of alienation from nature which are suspected to include difficulties with attention and executive function, increased rates of myopia, diminished use of all five senses, child and adult obesity, Vitamin D deficiency, and other physical and mental disorders.[3] Experiences in natural settings have long been touted as offering abundant restorative benefits to human health and our capacity to learn;[4][5] however, the relationship between declining exposure to nature and negative consequences that include increased stress, depression, anxiety, heart disease, and obesity has become more apparent in recent decades. [6][7][8][9][10]

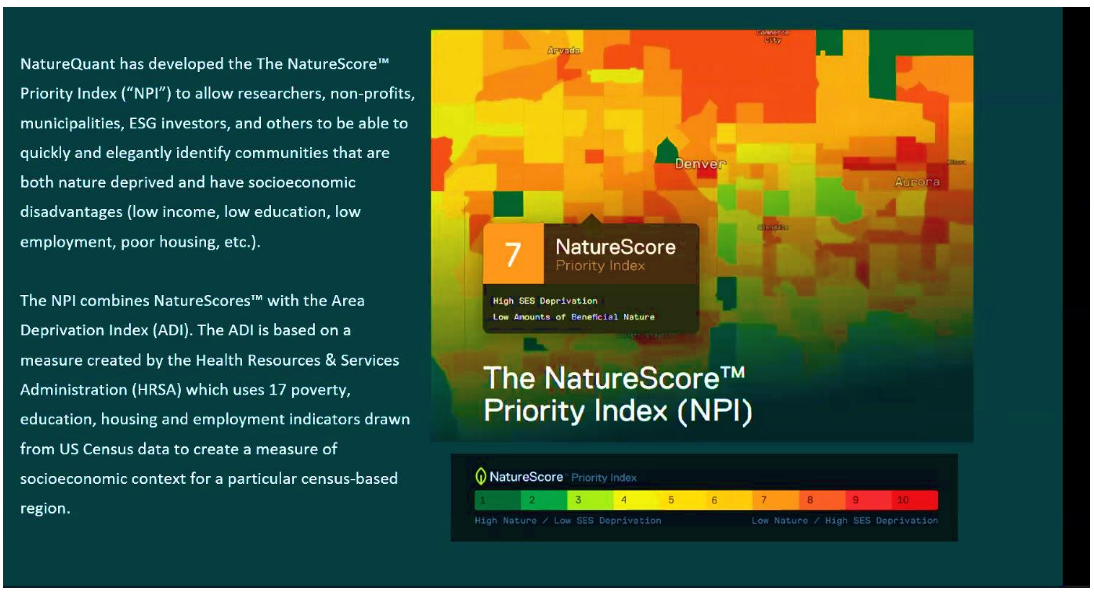
A rapidly expanding body of peer-reviewed research has established a clear connection between regular interaction with nature and measurable health benefits[11] that are comparable with those achieved through changes to diet and exercise; and, these interactions can provide effective and economical methods for preventing and treating human disease and illness.[12] One recent meta-analysis involving over 150 observational studies, 100 interventional studies, and over 300 million participants from 20 countries that investigated 100 different health outcomes demonstrated that increased exposure to nature can produce improvements to human health and longevity.[13] Other studies demonstrate that hospital patients with outside views of trees had significantly shorter recovery times than those with views of brick walls;[14] and that regular visits to forests have positive effects on immune function and the expression of anti-cancer proteins including increased numbers of cells that suppress tumors and microbial infections and reduced pro-inflammatory levels.[15] [16] [17]

Studies that analyze the public health benefits associated with tree canopy demonstrate that increased levels of vegetative cover in urban settings can reduce the negative effects of extreme heat which is projected to steadily increase over the remainder of this century. One study involving three metropolitan regions found that increased vegetative cover will help offset levels of heat-related mortality associated with heat wave conditions projected to occur in 2050 by 40 to 99 percent. [18] Additional information concerning how urban trees can be used to reduce periods of excessive heat can be found in the section entitled *Trees Can Help Communities Become More Climate Resilient* on pages 18 - 21.

Local governments now have online tools to measure the amount and quality of tree canopy and other natural features present at the neighborhood level to predict the impact that nearby natural features may have on health and longevity and to quickly identify communities that are both deprived of regular exposure to nature and are socioeconomically disadvantaged.

NatureScore measures the amount and quality of natural elements of any address by analyzing and blending various data sets and processed information within a given radius, including satellite infrared data, land cover classification, park data, tree canopy, air, noise and light pollutions, and aerial and street images. These elements are weighted to determine the health impacts of given natural elements on communities using machine learning processes. For more information see: https://www.naturequant.com/naturescore/

Nature Priority Index enables local governments to quickly identify communities that are both deprived of nature and may be disadvantaged by low income, low education, low employment, poor housing, etc. This index can be used to prioritize the delivery of green infrastructure and help inform public health delivery and policy. For more information see: https://www.naturequant.com/NatureQuant-NatureScore-Priority-Index.pdf



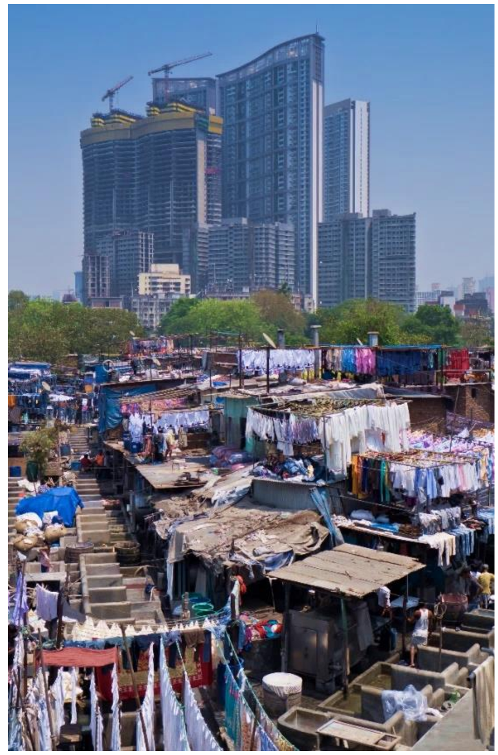
NatureQuant

NatureScore features mapping tools that can help users to identify the NatureScore associated with specific geographic areas. Image: NatureQuant

...the relationship between declining exposure to nature and negative consequences that include increased stress, depression, anxiety, heart disease, and obesity has become more apparent in recent decades.

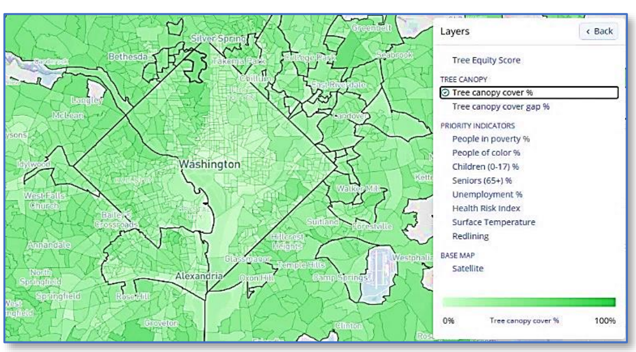
Section 2: Urban Trees Can be Used to Address Environmental Equity

"***Environmental equity***" has been defined as the fair treatment and meaningful involvement of all people regardless of race, color, gender, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. This concept has been broadened to include inequities associated with the level of tree canopy present in selected neighborhoods and the socioeconomic and environmental benefits potentially provided by this resource. Unfortunately, not everyone has equal access to trees and forests. Greenspaces tend to be less abundant in poorer neighborhoods, which tend to experience higher crime rates than their more affluent counterparts. While the causes of these phenomena vary, the disparity is real and urban forestry programs around the world have begun implementing public engagement and tree planting programs to help address the inequity - but much work remains to be done. (19)



Jensie De Gheest/ Pixabay

Local governments have access to several on-line tools to analyze environmental equity by relating tree canopy levels to income levels, ethnicity, distances to parks and open space and other demographics.



American Forests

One such tool, developed by American Forests called the ***Tree Equity Score,*** is used to weigh how communities are delivering equitable canopy coverage to all its residents. Census block data, tree canopy coverage, population density, income, rate of employment, surface temperature, race, age and health are used to calculate a score between 0 and 100 with 100 indicating a neighborhood has achieved "Tree Equity." This score can be calculated at both the neighborhood and jurisdictional scales. The Tree Equity Score website has online maps and filters to compare tree canopy coverage, poverty levels, percentage of children and seniors, unemployment, Health Risk Index, and surface temperature at census block levels. See the following links for information:

[Tree Equity Score]

[Tree Equity Score Map for Washington DC region]

An excellent example of a local program taking aim at environmental equity is the ***Thriving Earth Exchange Urban Heat Project*** which is a collaboration between Montgomery County, Maryland staff and volunteers with American Geophysical Union's Thriving Earth Exchange. The goal of this program is to build a tool that enables Montgomery County to understand impacts of urban heat on its communities by relating heat to social vulnerability and tree canopy cover (more on the Urban Heat Island Effect is provided on pages 18 and 19). Thus far, they have assembled a data repository containing information about urban heat distribution, tree canopy, land use, socioeconomic factors, and Montgomery County resources. The project team has begun developing a model that will hopefully predict levels of urban heat based on changes in land use. You can learn more about the Thriving Earth Exchange website here: https://thrivingearthexchange.org/project/montgomery-county-md/

...easy access to parks, gardens, forests, and other natural spaces should be understood to be critical to the mental and physical well-being of all residents of the Metropolitan Washington Region.

Section 3: Trees Can be Used to Build Cohesive Neighborhoods and Reduce Crime

The characteristics of neighborhood common spaces play a substantial role in the development of social ties among neighbors and can enable and motivate individuals to connect with their fellow community members in an increasingly global world. (20) (21)

Studies have found that vegetation levels in common open spaces are related to a sense of neighborhood safety and adjustment. One study examined 59 outdoor common open spaces in residential neighborhoods, 32 of which were relatively free of vegetation and 27 had more greenery. The results showed higher levels of social activity in the common open spaces with more greenery. The presence of nearby trees, vegetation and other forms of nature appear to enhance the strength of social ties among neighbors by encouraging use of common spaces. (22) (23)

Paul Bara/Pixabay

Similar results were found in two Chicago public housing developments where residents were more likely to use the space outside their apartment buildings when adjacent common areas had trees and landscaping compared to barren spaces. The green open spaces attracted both a greater number of people and a more diverse mix of youth and adults. The diversity in age groups suggests that inviting green open space facilitates opportunities to develop more social ties and shared supervision of children in inner-city neighborhoods. (24) Socially cohesive neighborhoods also proved to be better places for the elderly. When this age group forms strong social ties, they experience lower rates of mortality and suicide, reduced fear of crime, and better physical health. (25) (26) (27) (28) (29) (30) (31) (32) (33) (34) Youth that live in cohesive neighborhoods are less likely to participate in behaviors such as smoking, drinking, gang involvement, or drug use, as close-knit communities are better equipped to provide guidance and model behaviors. (35)

Some crime prevention specialists have advocated removal of vegetation in potential problem areas; however, the relationship between natural settings and crime prevention is more complicated than just the concept that vegetation provides hiding places for criminal activities. To the contrary, research indicates that the presence of vegetation is linked to lower levels of crime in residential settings, especially those located in very poor inner-city neighborhoods. (36) (37)

A recent study published in *Environment and Behavior*, saw declines in homicides from 1990 to 2015 in 218 cities. This study, which included Washington, D.C., suggests that efforts to increase urban vegetation may provide small but significant violence-reduction benefits. The authors of the study argue that nature's positive effects on cognition help prompt self-control and moderate negative emotions that might otherwise overwhelm individuals, and increased greenery may inspire residents to defend the safety and integrity of their neighborhood more vigorously thereby creating healthier, safer communities. (38)

Jensie De Gheest/Pixabay

Tree cover in residential settings have also been linked to increased sense of safety and less aggressive behavior. The presence of trees and well-maintained shrubs can transform blighted urban spaces into welcoming, well-used places that serve to strengthen ties among neighbors, increase informal surveillance by residents, and help to deter crime. (39)

...research indicates that the presence of vegetation is linked to lower levels of crime in residential settings, especially those located in very poor inner-city neighborhoods.

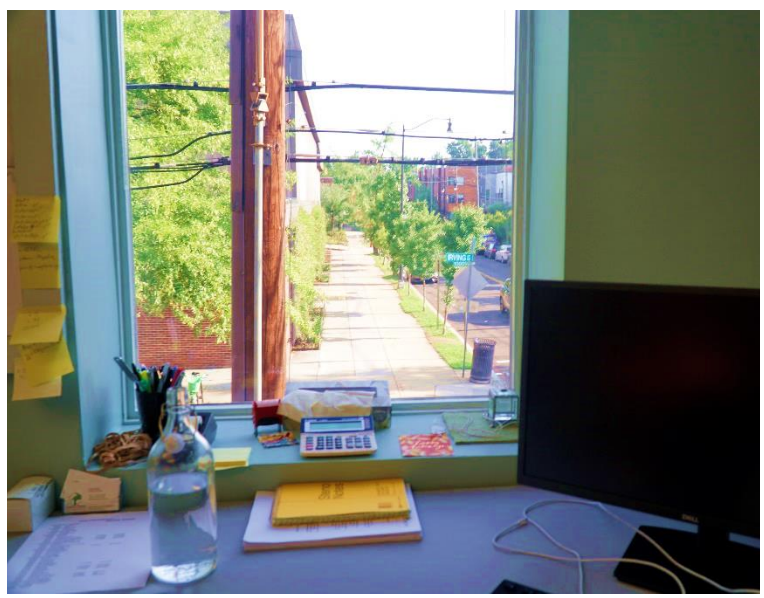
Section 4: Trees Can be Used to Increase Local Retail Business and Grow Healthy Economies

Independent merchants in business districts face competitive pressure from regional malls, big box, and online retailers. Local merchants can compete with corporate businesses by creating attractive, desirable shopping environments which incorporate urban trees and greenspace.

David Mark/Pixabay)

Studies have shown that tree-covered commercial shopping districts are more successful than those without tree canopy. In multiple studies, consumers showed a willingness to pay 12 percent more for goods and shopped for a longer period of time in shaded and landscaped business environments. (40) (41) (42)

Indirect value is added to increased customer traffic through increased levels of productivity by employees located in the stores with views of trees and natural features. One study found that desk workers with a window view of nature reported 19 percent fewer ailments in the preceding six months than indoor workers with no view of nature. (43) (44)



Casey Trees Foundation

Integrating nature into urban centers can stimulate local economic growth by making commercial districts more appealing and increase the competitive edge of communities by providing amenities and scenery that attracts highly skilled, creative, and productive workforces. (45)

Section 5: Trees Provide Cost-Effective Solutions and Great Investments

Studies conducted by the USDA Forest Service indicate that the monetary benefits associated with tree services outweigh the costs incurred while planting and maintaining the same trees plus costs associated with mitigating negative tree impacts. The study approximates that the average net benefits (benefits minus costs) of a medium sized yard tree equates to $960 over a 40-year period, while the net benefits of a large yard tree located on the western side of homes equates to $3,680 over the same period. The study also estimates that the monetary equivalents of the environmental services provided by trees (e.g., energy savings, stormwater- runoff reduction, improved air quality, and reduced atmospheric carbon dioxide) add up to more than three times greater than the cost associated with ongoing tree maintenance. (46)

Research conducted in 2010 by the USDA Forest Service in Portland Oregon found that, on average, street trees added $8,870 to a house's sale price and decreased the house's time on the market by 1.7 days.

Tree canopies and green spaces can considerably boost the market value of homes, thus contributing to the overall property tax base of communities. Research conducted in 2010 by the USDA Forest Service in Portland Oregon found that, on average, street trees added $8,870 to a house's sale price and decreased the house's time on the market by 1.7 days. The study also found that a single tree raised the value of multiple houses. A tree with an average canopy of 312 square feet (e.g., a mature red maple) added an average $7,130 in value to the house it fronted, plus additional value to neighboring houses. Only about one-third of the total benefit goes to the property where the tree is located. The rest of the benefits are spread out to neighboring properties within 100 feet, and in the neighborhoods studied, added an average combined value of $12,828 to the houses (typically 7 to 8) located within that radius. (47)

Another study conducted in Spain found that for every 100 meters (328 feet) further away from a green area means a drop of 300,000 pesetas ($2,026) in housing prices and reached the conclusion that home proximity to greenspace area is more relevant than the size of that greenspace. This has important policy implications for urban planning since it suggests that the presence of small greenspaces throughout a city provides more socioeconomic benefits than a few large parks. (48)

Barry Brown/Pixabay

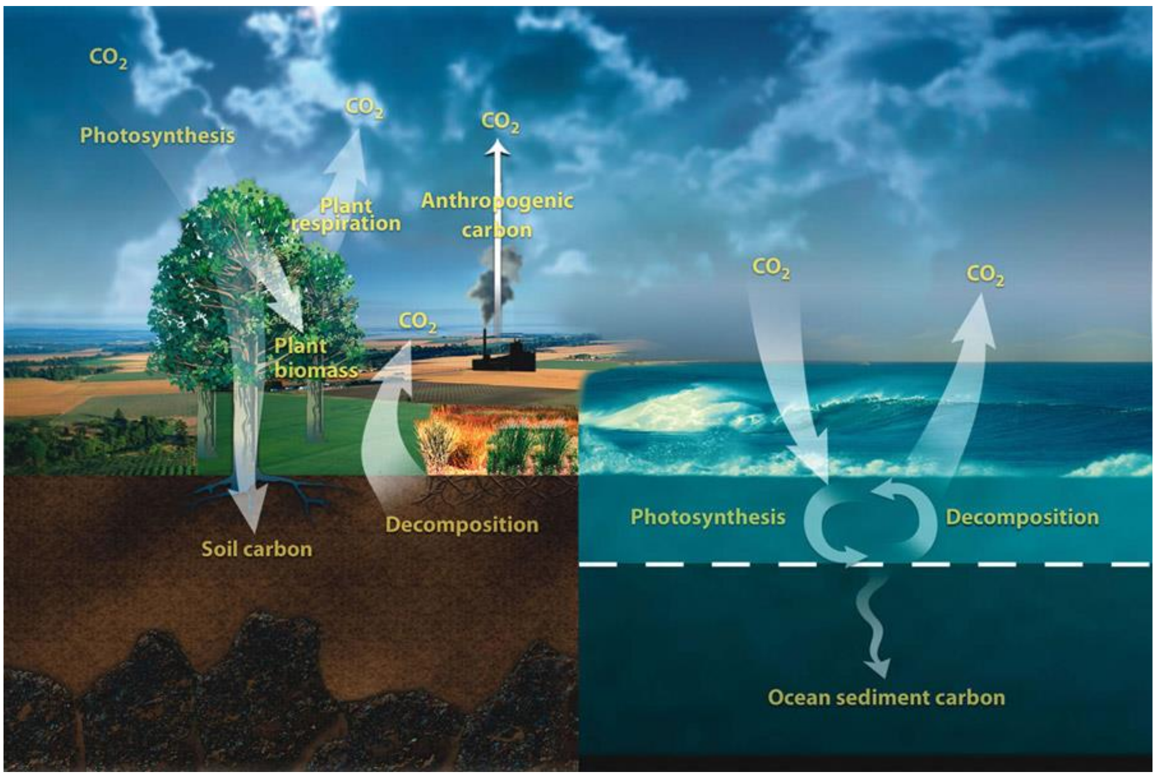
Urban settings often contain vacant or abandoned land. Nationally, an average 16.7 percent the landmass of large cities in the United States is considered vacant, with approximately 4 percent of city addresses unoccupied [49] There is strong economic evidence to support investment in the conversion of these areas into natural infrastructure. A study conducted at the University of Pennsylvania, in Philadelphia, found that homes near vacant properties experienced gains in value of 18 to 21 percent following the conversion of nearby vacant lots into green space such as small pocket parks. Homes near the newly converted green spaces experienced a median gain of $34,468 in value over a five- year period. The study went on to estimate that for every dollar spent to convert and maintain a vacant lot there was a $7.43 gain in additional property tax revenues for the City of Philadelphia. [50]

Pexel/Pixabay

...research has established a clear connection between regular interaction with nature and measurable human health benefits that are comparable with those achieved through changes to diet and exercise; and that these interactions can provide effective and economical methods for preventing and treating human disease and illness.

Section 6: Trees and Forests Can Help Mitigate Climate Change

Trees and forests play a critical role in our planet's "carbon cycle," which represents the transfer of carbon between the atmosphere, oceans and seas, rocks and soil, and plants and animals. As trees grow and expand, they absorb and retain carbon in wood tissues. In this capacity they are considered as carbon "sinks." As trees die and decompose, they gradually release carbon back into the atmosphere. In this capacity they are considered as carbon "sources." Both of these processes must be accounted for when accessing the net contribution of trees and forests to the planet's carbon cycle; however, the amount of carbon associated with trees acting as sinks outweighs their carbon emissions as long tree populations and associated soil conditions remain healthy and intact.



Source: Office of Biological and Environmental Research of the U.S. Department of Energy Office of Science

Trees help mitigate climate change by sequestering atmospheric carbon dioxide and storing it in wood tissues. [51] [52] . A recent iTree Landscape analysis of the 2018 tree canopy existing on the entire landmass of COG member jurisdictions demonstrates that regional tree and forest canopy sequesters approximately 1.42 million tons of carbon on an annual basis. The monetary equivalent using alternative carbon sequestration practices is valued at over $266 million dollars annually according to the Chesapeake Tree Canopy Network. The 2018 carbon sequestration values provided by the tree canopies of most COG member jurisdictions are provided in The Chesapeake Tree Canopy Network's ***Tree Cover Fact Sheets*** in the Appendix on page 91.

Recent studies have estimated the levels of carbon sequestration and storage provided by the trees of several COG jurisdictions including Montgomery County, Maryland and the District of Columbia. The amount of carbon stored in Montgomery County's forests and trees is approximately 11.3 million metric tons, or around 41 million metric tons of CO2, as of the latest period of analysis (2011-2016).

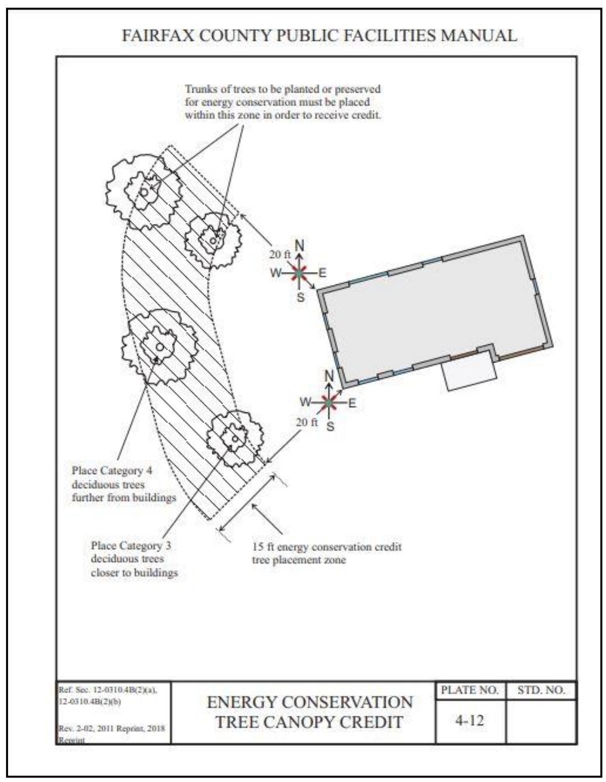
Around 8.2 million metric tons of carbon (over 30 million metric tons of CO2) are in forests, and around 3.1 million metric tons of carbon (over 11 million metric tons of CO2) are in trees outside forests. (53)

A 2015 ecosystem analysis of Washington D.C. tree canopy indicates that the District's trees sequestered 26,700 tons of carbon per year (valued at $1.90 million/year) * and stored 649,000 tons of carbon (valued at $46.2 million). (54)

If situated correctly in the landscape, trees can reduce heating and air conditioning demands in nearby buildings, thereby reducing carbon dioxide emissions from the combustion of fossil fuels for power production. Typically, trees located closer to buildings building have the greatest effect on energy use.(55) In general, large trees located on the western side of buildings provide the greatest average reduction in cooling energy savings and large trees to the south side tend to lead to the greatest increase in winter energy use.(56)

Trees in Washington, D.C. are estimated to reduce energy-related costs from residential buildings by $705 thousand annually. D.C. trees also provided an additional $167,912 in value by reducing the amount of carbon released by fossil-fuel based power plants (a reduction of 2,360 tons of carbon emissions). (57)

A report published by the USDA Forest Service in March 2018 entitled "i-Tree Ecosystem Analysis, Fairfax County 2017, Urban Forest Effects and Values" estimated that the tree canopy of Fairfax County, Virginia was estimated to reduce energy-related costs of residential buildings by $34,300,000 annually. The report also estimated that Fairfax County trees acted to avoid 51,900 tons of carbon emissions annually that would have otherwise been released by fossil fuel-based power plants to generate energy for that same jurisdiction. This service was valued at $6,740,000. (58)



Fairfax County, Virginia provides incentives to home builders that plant deciduous trees within a 15-foot energy conservation planting zone located 20 feet away from the Southwestern, Western, and Northwestern sides of residential structures. 2018 Public Facilities Manual. Image: Fairfax County, VA

Section 7: Trees Can Help Communities Become More Climate Resilient

The Union of Concerned Scientists define climate resilience as "about successfully coping with and managing the impacts of climate change while preventing those impacts from growing worse. A climate resilient society would be low-carbon and equipped to deal with the realities of a warmer world." The United Nations has identified the major impacts of climate change as

- Hotter Temperatures
- More Severe Storms
- Increased Drought
- Warming Rising Oceans
- Species Extinctions
- Food and Water Shortages
- Increasing Health Risks/Disease
- Rising Poverty Rates
- Displacement of Communities [59]

The previous section "*Trees and Forests Can Help Mitigate Climate Change"* identifies how trees and forests can absorb, store carbon dioxide, and avoid emissions of this greenhouse gas. This section describes several ways COG member jurisdiction can use trees as one part of a cost-effective portfolio of climate adaptations to become more resilient to the following effects of climate change:

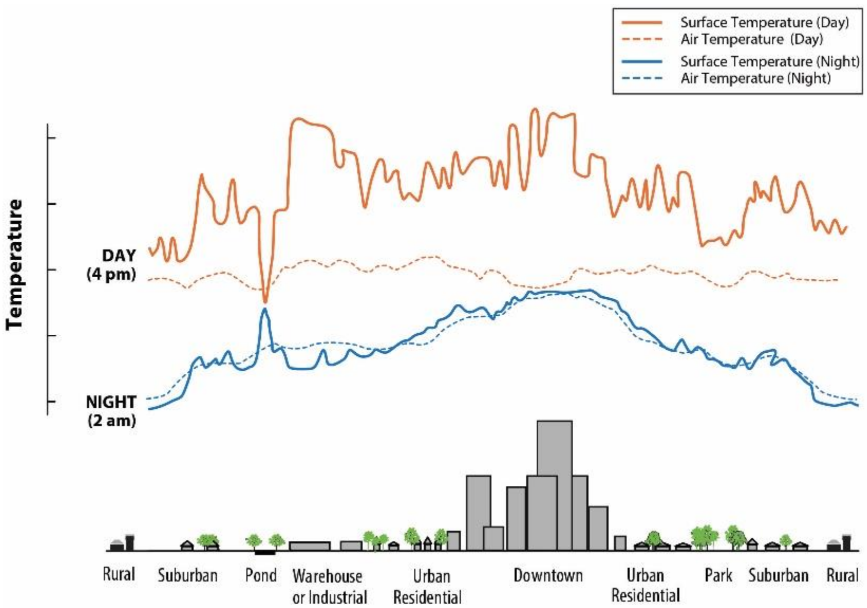
- Periods of excessive heat which magnify the impacts of Urban Heat Island effect
- Increased levels of air pollution including particulate matter from forest fires and other sources
- Increased number of storm events which are predicted to increase in severity and could lead to flash floods, property damage, and soil erosion

Tree planting should not be viewed as a replacement for other technologies. However, they can be used in conjunction with those technologies to improve air quality and make urban centers cooler. Moreover, tree planting provides many other benefits beyond cleaning and cooling air. Planted in the right location, trees can help make air healthier while also making our communities more attractive, livable, and resilient to the adverse impacts of climate change. In areas outside urban centers, ecosystem-based climate adaptation approaches such as, restoration of wetlands and upstream forest communities have been shown to be effective in reducing flood risks and excessive heat [60]

Periods of Excessive Heat and the Urban Heat Island Effect

According to data collated by the US National Centers for Environmental Prediction the first week of July 2023 was the hottest week on record for the entire planet, with an average global air temperature of 17.18°C (62.9°F) reached on Tuesday, July 4, 2023. Human activities, including greenhouse gas emissions (GHG), have caused global warming with global surface temperature reaching 1.1°C (2.2 °F) above 1850–1900 averages in 2011–2020. Global GHG emissions projected for 2030 make it likely that global warming will exceed 1.5°C (2.7°F) during the 21st century.[61]

Urban centers have large areas of impervious surfaces and buildings that tend to absorb and store significant amounts of energy from the sun and other sources. The heat energy is stored and released over significantly longer periods of time than the time it takes to dissipate in surrounding suburban and rural areas. This can result in urban centers measuring 26°F (2°C) or higher in air temperature than surrounding areas. This phenomenon is referred to as the Urban Heat Island effect (UHI). (62)



Source: U.S. EPA, Learn About Heat Islands

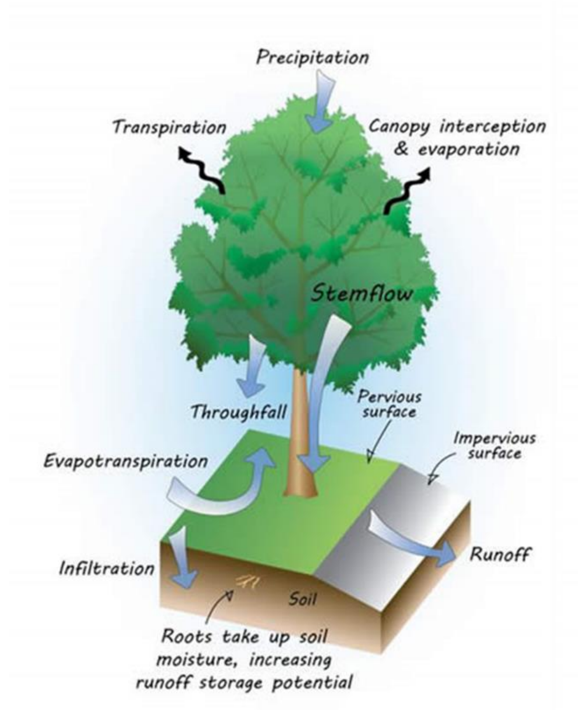
In 2018, the UN Department of Economic and Social Affairs predicted that 2.5 billion additional people are predicted to move to cities globally during the 21st Century. This rapid urbanization is expected to result in the vast majority of humanity living in urban centers by 2050. Climate change is dramatically increasing global temperatures and intensifying UHI impacts on people living and working in urban centers, including those located in the metropolitan Washington region.

Epidemiologic studies show a significant rise in overall mortality during periods of high temperature which do not have to be extreme to cause an increase in overall mortality, but simply need to rise above the average summer temperature for a given area. The majority of the increased mortality occurs because excessive temperatures represent elevated risk factors to a large range of diseases. For example, higher temperatures increase the risk of heart attack and stroke, particularly in the elderly. Taking all mortalities related to high temperatures into account, periods of high temperatures cause more mortalities globally than any other weather-related disasters, killing on average 12,000 people annually. (63)

Trees and other plants help cool ambient air and surface features such as paving and buildings through shade and evapotranspiration. Urban trees can mitigate heat in urban areas and associated adverse impacts on human health, energy consumption, and urban infrastructure. (64) A study comparing Central European urban areas with tree canopy to those lacking tree canopy found that Land Surface Temperatures (LTS) observed for areas covered by tree canopy were on average 8 - 12°K (14.4° - 21.4°F) lower, and that treeless urban green spaces are overall less effective in reducing LSTs, and their cooling effect is approximately 2 - 4 times lower than the cooling induced by urban trees. (65)

Particulate Matter: An Ongoing Health Concern

Particulate matter (PM) is defined as any particle that can be transported in the atmosphere. PM is classified by the size of the particle, and size is important in this context because it determines how easily and deeply the particles can be inhaled into lungs. (66) Globally, PM is the air pollutant with the largest impact to public health. Municipal and national governments worldwide continue to struggle to reduce particulate matter concentrations. This pollutant is responsible for an estimated 3.2 million premature deaths annually in both rural and urban areas. This level of mortality amounts to over 5 percent of all global premature deaths. (67) PM also causes a range of nonfatal health problems that affect tens of millions of people yearly. including coughing, asthma, bronchitis, irregular heartbeat, and non-fatal heart attacks. (68)



Source: US Environmental Protection Agency

People who are at risk for health effects from wildfire smoke (such as the 2023 Canadian wildfires) are more concerned about particles 10 micrometers (μm) in diameter or smaller because these particles can pass through the nose and throat and enter lungs, with fine particulate matter (< 2.5 μm) possibly passing into blood circulation. Fine particles can affect the lungs and heart and cause serious health effects. Coarse particles (> 10 μm) are of less concern because they typically do not enter the lungs but can still cause inflammation in eyes, nose, and throat tissues. (69)

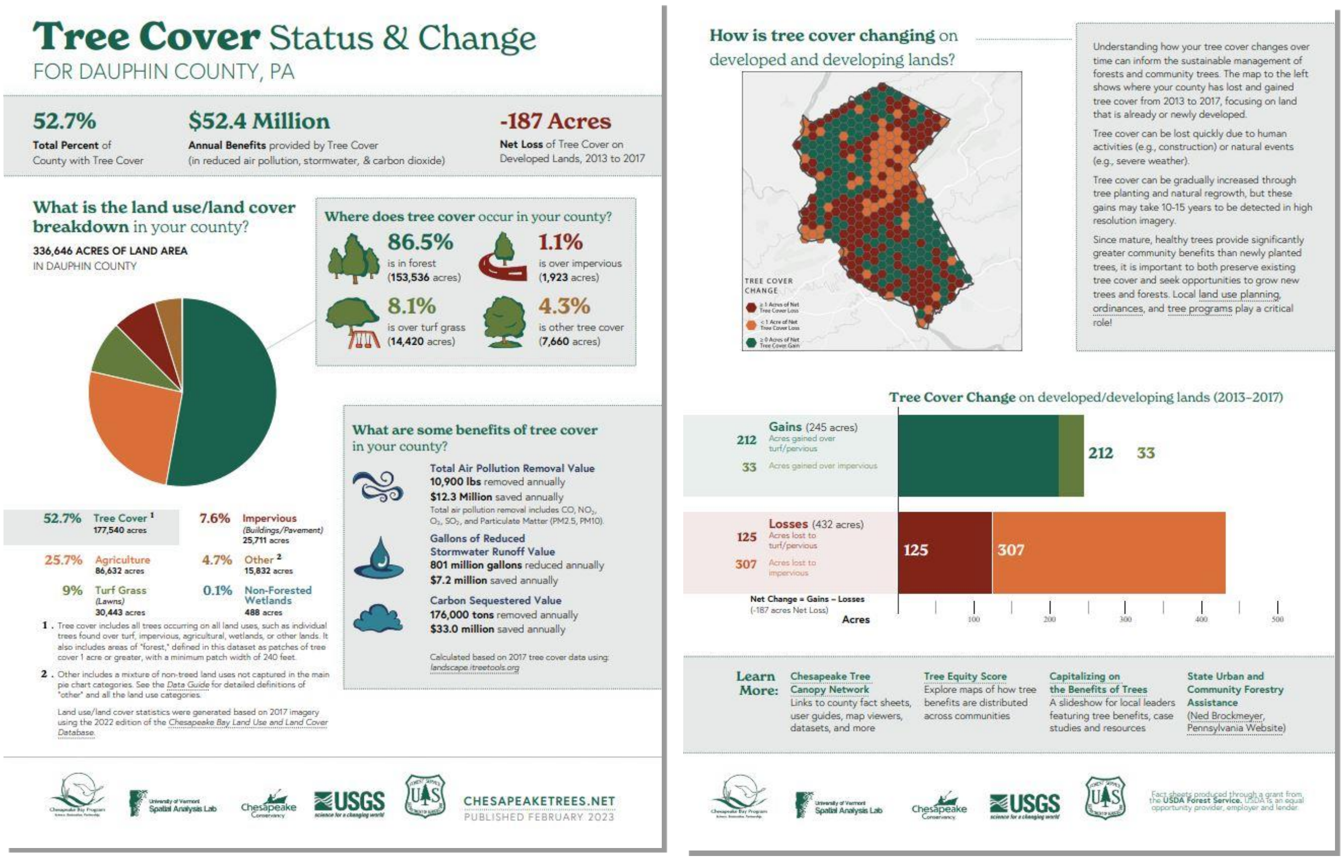
PM is removed by trees through a process called dry deposition which occurs when particles in the atmosphere deposit themselves on a surface decreasing the atmospheric concentration of PM. (70) Much of PM2.5 becomes incorporated into the cuticles of leaves, while a portion of PM10 is resuspended as a function of wind speed. (71) (72) The remainder of PM10 is eventually washed off to the ground by precipitation. (73) (74) (75) (76) Most of the PM filtering and cooling effects created by trees are fairly localized, so densely populated cities with high pollution levels tend to see the highest overall return on investment from planting trees. Urban forest planners should consider taking advantage of these localized effects by planting groups of trees near vulnerable populations such as near schools, hospitals and elderly care facilities. (77) While we cannot rely on tree conservation practices alone to solve all our air quality and heat problems, they certainly can be a cost-effective component of the overall solution while providing additional socioeconomic and environmental services to targeted communities.

Reduction of Stormwater Runoff and Potential Flooding

Trees and other forms of green infrastructure reduce flood risks by increasing in-place infiltration, decreasing the volume of stormwater runoff flowing into local waterways, and enhancing the natural function of floodplains. (78) A study in Beijing calculated that when community projects increased greenspace by 10 percent, constructed a stormwater retention pond, and converted 50 percent of impervious area to porous surfaces that the volume of stormwater runoff was reduced between 85 percent and 100 percent and the peak rate of discharge was lessened between 92.8 percent and 100 percent. (79)

Again, as is the case with other tree services, trees, forests and other forms of green infrastructure are not likely to meet all the stormwater management and flood prevention needs of any given community; however, they can be a very valuable piece of the puzzle while simultaneously providing additional socioeconomic and environmental services. An example of these value-added tree services comes from a City of Philadelphia assessment of two infrastructure options designed to meet the same stormwater needs but offering significantly different benefits. The assessment compared a 50/50 percent grey/green infrastructure project with a 100 percent grey infrastructure project. The net value of the social, environmental, and economic benefits provided by the 50/50 percent grey/green option was estimated at $2.85 billion (including increased recreational opportunities, increased property value, wetland services, reduced heat stress, water and air quality improvements, energy savings, and reduced emissions), while the benefits from the traditional grey infrastructure option were estimated at only $122 million over the same period. (80) (81)

The stormwater services and monetary equivalents provided by tree canopy at regional scales can be very significant. A recent iTree Landscape analysis of the trees and forests covering the entire landmass of COG member jurisdictions in 2018 estimates that these natural features help control 6.2 billion gallons of stormwater on an annual basis. The monetary equivalent of that level of stormwater management service using alternative mitigation practices is valued at approximately $55 million dollars annually according to the Chesapeake Tree Canopy Network.



Tree canopy fact sheets are now available for all Counties and some municipalities located in the Chesapeake watershed. The fact sheets provide 2018 tree cover levels, tree-related services, and benefits (derived using i-Tree Landscape software) and changes to tree canopy levels between 2014 and 2018. This handy website features a map viewer to find your county's fact sheet and associated air pollution removal services and monetary values; gallons and monetary values for stormwater runoff reduction, and annual rates of carbon sequestration and monetary values for most COG Member Jurisdictions. https://chesapeaketrees.net/understand-your-canopy/

Web Images: Chesapeake Tree Canopy Network

Section 8: Trees Provide Significant Levels of Environmental and Ecological Services

Roads, buildings, stormwater facilities, and water treatment plants often come to mind when people think of public assets; however, trees and forests represent natural infrastructure that are a cost-effective, sustainable, and socially beneficial solutions — and generate a broader range of services than that provided by traditional gray infrastructure. [82]

Research conducted over the past 35 plus years has resulted in the availability of tools to quantify the services and values associated with trees. These values include monetary equivalencies and return on investment for the services and benefits provided by trees; both on an individual and community-wide basis. Irrespective of location, virtually all trees in the urban forest provide multiple services. As demonstrated in this section, trees add benefits and increased values to regional environmental, social, economic, and ecological processes that translate into beneficial impacts to COG member jurisdictions.

Improvements to Air Quality

Poor air quality is a common problem in urbanized areas. It can represent a serious public health concern and some pollutants damage buildings, public infrastructure, vegetation, and ecosystems, and can reduce visibility. Trees and forests help improve air quality by reducing air temperature via shade and evapotranspiration, directly absorbing pollutants from the air, and reducing energy consumption in buildings which in turn reduces air pollutant emissions from the power plants. Trees also emit biological volatile organic compounds (BVOC) such as isoprene and monoterpenes as part of their biological processes. BVOCs can contribute to ozone formation during periods of hot, sunny weather. However, studies demonstrate that increasing tree canopy leads to overall reduced ozone formation as trees directly absorb the air pollutant [83]

Strategic tree planting and tree conservation practices have been approved by the U.S. EPA as voluntary measures to help communities meet federal air quality standards by mitigating ground level ozone formation, particularly through reduction of ambient air temperatures and urban heat island effect.[84] Many states have incorporated these measures in their State Implementation Plans, which are required by the Clean Air Act. The USDA Forest Service has published free software tools to evaluate the air pollution removal capacity of forests and trees for pollutants regulated by the Clean Air Act. These include carbon monoxide, nitrogen dioxide, ozone, coarse particulate matter (PM10), fine particulate matter (PM2.5), and sulfur dioxide. For more information about these tools see: https://www.itreetools.org/

Three examples of air quality improvement services provided by the tree canopies of three COG member jurisdictions. All data were estimated using the iTree UFORE model developed by the U.S. Forest Service, Northern Research Station:

- The tree canopy of Washington D.C. trees is estimated to remove 619 tons of air pollutants per year.[85]
- The tree canopy of Fairfax County, Virginia is estimated to remove 4,538 thousand tons of air pollutants per year.[86]
- The trees of Prince George's County, Maryland are estimated to remove 5,100 metric tons of pollutants annually. [87]

USDA Forest Service

Wildlife Benefits

Native forests represent very diverse ecosystems, hosting the majority of terrestrial plant and animal species. The Maryland Department of Natural Resources reports 115 natural communities (recurring assemblages of plants and animals found in particular physical environments) present across terrestrial, palustrine, estuarine systems in which tree species represent the dominant feature. (88) These vegetation communities represent balanced ecosystems where soil, plants, and animals are interdependent and provide habitat, food, and migration stopovers for numerous mammals, birds, insects, and other organisms.

Jürgen Richterich/Pixabay

Due to their relative height, tree species are the primary constituent of the emergent, upper canopy and sub-canopy strata of forest and woodland communities. Woody shrubs, herbaceous plants, vines, non-vascular plants and epiphytes; decaying leaf litter, root mass, fungi, soil biota; and abiotic components populate the understory, shrub layer, forest floor and soil strata. This structure provides physical space, nesting materials, and protection during reproductive behavior; places to rest; raise young; and elevated perches required to spot, hunt, capture, and eat prey.

One example of a group of organisms that are highly dependent on forests are the larval stages of Lepidoptera (butterflies, skippers and moths) which are pollinators of plants, many of which are crops. The larva stage of Lepidoptera, called caterpillars, represent the mainstay of most bird diets in North America - particularly at the time of year when birds are rearing their young. A single large tree can host thousands of individual caterpillars. Douglas W. Tallamy's book *Nature's Best Hope* reports that at least 934 caterpillar species were supported by oak species, 557 of which occur in the Mid-Atlantic region, with many caterpillars depending on the Eastern White Oak alone for habitat. (89) Some of the bird species that eat caterpillars also eat crop damaging and human disease carrying insects and help to keep their populations in check. Why do these types of relationships matter to humans? Natural communities are key components of biological diversity. The conservation of natural communities keyed on plant constituents serves as a surrogate for conserving a multitude of non-plant species including invertebrates, insects, birds, reptiles, mammals and others. According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), biodiversity is now declining faster than ever before. (90) Biodiverse ecosystems provide many of the materials we need for food, shelter, clothing, and more. Healthy ecosystems make earth habitable for humans. When trees, forests, meadows, savannahs, wetlands and other ecosystems are entirely removed, degraded or fragmented into smaller and smaller pieces for development, farming and other purposes, our natural life-supporting systems begin to fail, putting our species, *Homo sapiens* at ever-increasing risk.

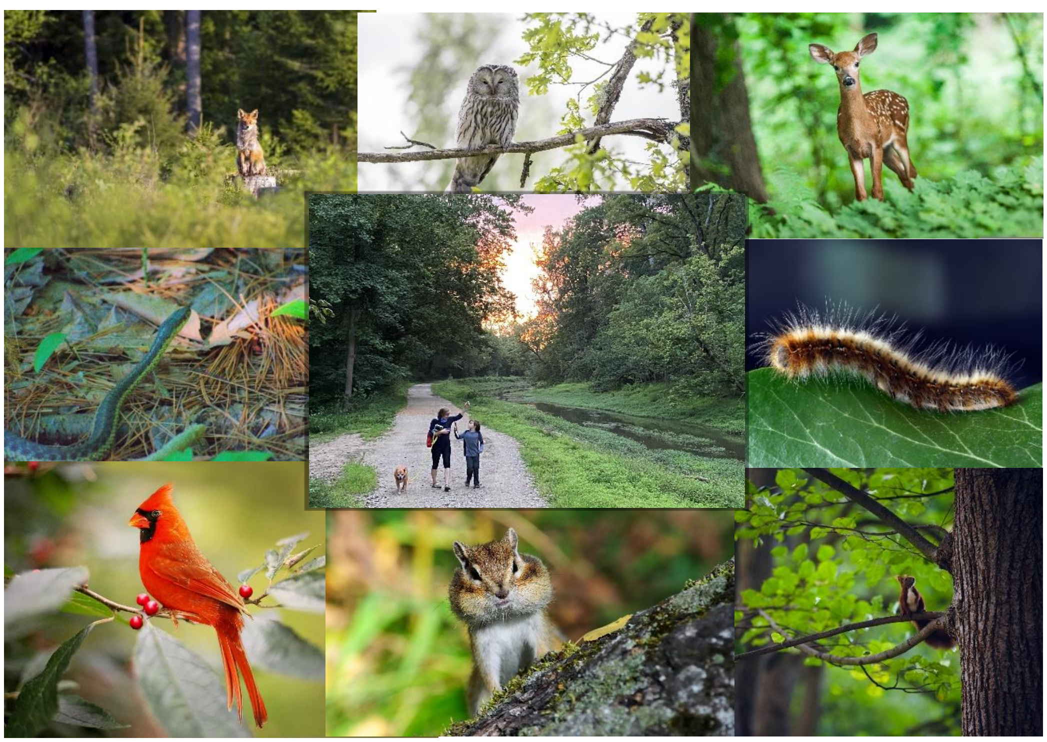
...biodiversity is now declining faster than ever before. Biodiverse ecosystems provide many of the materials we need for food, shelter, clothing, and more.

Can urban trees provide significant levels of wildlife benefits? Yes, urban trees, including yard and street trees can provide many of the same wildlife services as native forest communities, although the types of wildlife that typically benefit are somewhat different, primarily because of the lack of larger corridors that larger wildlife species seem to prefer for daily movement. Birds and insects, some of which are migratory appear to benefit the most.

In an urban setting, street trees and nearby yard trees create linear corridors of habitat, connecting otherwise isolated areas to each other and out to rural surroundings. Trees and other vegetation along highways, waterways, and railways are also important to wildlife for the same reason. [91]

Urban tree canopy can provide opportunities for nesting, shelter, sources of food, migration rest stops, noise reduction and shade. However, certain families of trees and individual native species appear to provide more benefits to wildlife than others [92] For example, red cedar (Juniperus virginiana) provides year-round cover from predators and storms; produces cones and fruit that are available as food for birds from early summer through winter; and provide places for more than 30 native Lepidoptera to deposit eggs. As previously mentioned, the oak family (Quercus) provides wildlife with habitat, breeding spots, and food for a large range of organisms. The flowers (catkin) of Willow species (Salix spp.) are among the first trees to flower in Spring and provide native bees with an early start to collect food. Beech, primarily American beech (Fagus grandifolia), provides excellent habitat and can produce copious amounts of beechnuts that allow birds and mammal species to build up fat reserves, so they survive winter months when sources of food become scarcer. [93]

Although urban trees can provide similar wildlife benefits to forest and woodland communities, urban planners must exercise diligence when planting tree species that will attract wildlife near busy paths, roads, highways, and airports where increased levels of wildlife traffic have potential to result in life-threatening injuries to humans and wildlife alike.



Fox Image by Erik Karits from Pixabay; Owl Image by Erik Karits from Pixabay; Deer Image by Wild Pixar from Pixabay; Snake Image by Benjamin Townsend from Pixabay: Tow path image by Michael Knapp; Caterpillar Image by Ian Lindsay from Pixabay; Chipmunk; Squirrel Image by Grzegorz Szukszta from Pixabay

Section 9: The Need to Recognize and Manage the Costs, Damages and Risks Associated with Trees

Although it can be tempting to exclusively focus on the positive services and benefits of trees, their potential to become associated with unacceptable levels of expense, property damage, human injury and disruption of vital services and access is very real and cannot be ignored. In reality, if our goal is to maximize the services and benefits provided by trees, we must be willing to acknowledge their inherent costs and risks and take steps to manage these aspects.

Costs associated with trees can be socioeconomic (e.g., planting, ongoing maintenance, repairs to paved surfaces and sidewalks, increased allergies to pollen, etc.) or environmental (e.g., volatile organic compound emissions, etc.). Trees located in urban settings have increased potential to damage property, utility lines, and public infrastructure as a result of tree failure, falling branches, root growth, and storm damage. Depending on location, dead and dying trees can represent unacceptable levels of risk which, if left unattended, can result in human injury and/or fatality.

JSMimages, Alamy Stock Photo

The negative impacts of trees are more easily observed in urban settings where they tend to be located more closely to buildings, roads, and infrastructure; however, these impacts can largely be avoided when appropriate tree species are selected and are planted in suitable locations that support adequate root development. Although studies conducted by the USDA Forest Service indicate that the monetary benefits associated with tree services outweigh the costs associated with planting and maintaining trees and the costs associated with mitigating negative tree impacts to public infrastructure, (94) these cost-benefit studies rightly do not attempt to assign a monetary cost to human fatalities and injuries caused by trees. However, the probability of being killed or injured by a falling tree or limb is very low.

...studies conducted by the USDA Forest Service indicate that the monetary benefits associated with tree services outweigh the costs associated with planting and maintaining trees...

One study prepared by the Centre for the Decision Analysis and Risk Management. Middlesex University in the United Kingdom estimated that the average individual risk of death to a person in the UK is in the region of 1 in 10 million per year based on an analysis of tree-related fatalities in the UK for a 10-year period starting January 1, 1999. For comparison the study indicates that the risk of dying from a road accident was 1 in 16,800. The study concluded that this was by any standard an exceptionally small risk and lies well within in the 'broadly acceptable' risk region as defined by the UK Health and Safety Executive. [95] Another recent study conducted using emergency room data from a hospital in New South Wales Australia found that of 13,884 total trauma admissions to John Hunter Hospital over the study period, there were 37 patients admitted to hospital with tree-related injuries. The Hospital involved in the study has a service area of approximately 143,000 km^2 (55,213 sq. miles) with a mixed rural and metropolitan population of approximately 1.1 million people. The study concluded that when compared to other mechanisms such as road trauma, which accounts for approximately 11,000 serious injuries and 300 deaths in New South Wales per year that injury and death related to accidental tree failures is extremely rare. [96]

A study published in 2008 found that 407 people were killed by "wind-related tree failures" in the U.S. between 1995 and 2007. The study reports that the most common cause of the deadly fallen tree was a thunderstorm (41 percent), followed by high winds (35 percent), tropical cyclones (14 percent), tornadoes (7 percent), and snow and ice (3 percent). Most (62 percent) of the deaths were males while the median age was 44years. The most common location of the fatality was in a vehicle struck by the tree or a vehicle that crashed into a downed tree on the road (44 percent), followed by persons outdoors (38 percent), in mobile homes (9 percent), and in frame houses (9 percent). Persons killed by wind-related tree failures during hurricanes and tornadoes were more commonly at home (40 percent) when struck than those killed at home by thunderstorm and high winds (13 percent). The seasonality of the deaths varied by weather type with deaths in thunderstorms clustered during May to August; high winds in October to April; hurricanes during August to October; tornadoes during April and November; and during snow and ice storms in December to April.

The study provides statistics gleaned from the Mid-Atlantic region between 1995 to 2007. The District of Columbia reported two deaths attributed to tree failure during thunderstorms, and the Commonwealth of Virginia reported 16 deaths, seven of which were attributed to tree failure as a result of tropical cyclones (a.k.a. hurricanes). The death rate from wind related tree failures for the entire United States was reported as 1.45 deaths per million population during that 12-year timeframe. [97]

Even healthy and sound trees may be damaged or felled by strong winds or ice accumulations, so severe weather safety recommendations should continue to emphasize seeking shelter in sturdy buildings when any type of high winds are expected. If trees are planted near a house for shade and other benefits, then they should be inspected regularly for structural defects. Large dead branches should be pruned, and the entire tree removed if structural defects are significant. Roadside trees provide shade and reduce air pollution near streets, roads and highways, but may represent high risk hazards to motorists during periods of high winds.

The statistics provided in this section emphasize a need for COG member jurisdictions to encourage public agencies and private property owners alike to take steps to maintain trees in a healthy and structurally sound condition so that risks are minimized. Even healthy and structurally sound trees may be damaged or toppled by strong winds or ice accumulations, so severe weather safety recommendations should continue to emphasize seeking shelter in sturdy buildings when any type of high winds are expected.

A tree risk assessment program should be established for publicly owned trees, especially those located in public areas such as along roads, parks, governmental facilities, and schools. COG member jurisdictions should consider requiring managers of public tree maintenance programs and private tree care companies to earn and maintain the Tree Risk Assessment Qualification credential administered by the International Society of Arboriculture. For more information on the credential see: https://www.isa-arbor.com/Credentials/ISA-Tree-Risk-Assessment-Qualification

International Society of Arboriculture

Section 10: The Need to Monitor and Address Threats to our Regional Tree Canopy

There are currently multiple threats to the trees and forests located in our region. Providing an in-depth analysis of each threat exceeds the scope of this publication. RTCS has been tasked with identifying current and possible threats in a Region Tree Action Plan. That publication will identify strategies, tactics, and practices to help local governments act both locally and collaboratively to address threats of mutual concern. The following list identifies the most current and prevalent and issues that currently threaten Metropolitan Washington's tree and forests.

Ongoing threats to Urban Tree Canopy

- Insufficient species diversity
- Inadequate planting spaces
- Insufficient funding for tree programs
- Wrong tree, wrong place
- Availability of good quality plant material

Ongoing threats to Native Forest and Woodland Communities

- Over browsing of tree seedlings by high deer populations
- Deterioration of forest ecosystem health due to forest fragmentation and human activities
- Invasive plants species that inhibit the germination and growth of native plants
- Conversion of forested properties and tree cover into other uses
- Lack of age-diversity - forests that lack diverse age classes are vulnerable to loss all at once as mature trees reach the end of their natural lifespan or die disease or pests.

Shared Threats to Urban Tree Canopy & Native Forests

- Impacts of climate change on individual species and entire forest communities
- Outbreaks of pests and diseases that cause significant ecological and economic impacts
- Development and redevelopment of land
- Absence of regional collaboration over matters relating to tree conservation and reforestation
- Lack of public awareness and support for tree programs
- Increasing severity and frequency of storm events

Development and redevelopment of land within the COG region – the impacts of land development and redevelopment on our regional tree canopy will continue to be an ongoing threat to existing trees and forests which in turn reduces the capacity of our regional canopy to provide valuable services.

However, land development processes also provide an opportunity to either preserve or plant high quality and strategically functional tree canopy by means of land development review processes.

An analysis of tree canopy gain and loss is provided in the 2022 Chesapeake Bay Program Land Use/Land Cover Project. The following table tracks changes in tree canopy levels in COG jurisdiction from 2014 to 2018. Change data is provided for 14 COG jurisdictions and covers the entire COG land area. It is important to note that the 2022 Chesapeake Bay Program Land Use/Land Cover Project tracks gain/loss in four broad classes of tree canopy: 1) Forest, 2) Tree Canopy over Turf Grass, 3) Tree Canopy over Impervious Surfaces, and 4) Tree Canopy, Other. The tree canopy located in COG jurisdictions is comprised of all four of these classes. Consequently, the canopy change figures provided in Table 1 reflect net amounts of canopy change after gains and losses have been calculated. The gain and loss data for the four classes of tree canopy will be examined in more detail along with class-specific conservation strategies in the upcoming Regional Tree Canopy Action Plan.

The data in Table 1 indicates that tree canopy covered 51.4 percent of the COG landmass in 2014, and 50.6 percent in 2018. Although there were minor canopy gains in several jurisdictions during that four-year period, the data indicates the COG region experienced an overall 0.8 percent decline in tree canopy over that four-year period. The decline equates to a loss of approximately 17,133 acres of tree canopy. A significant portion of canopy loss occurred in core COG jurisdictions. These losses are primarily linked to piecemeal “infill” development, redevelopment of older residential neighborhoods, and expansion of transportation corridors; however, other factors such as aging tree populations, storm damage, tree mortality from diseases and pests, impacts of invasive plants, and tree removal associated with property maintenance are thought to have contributed to the regional decline in canopy coverage as well.

Nayuta/pixabay

Table 1. Tree Canopy Gain/Loss within the Metropolitan Washington Council of Governments Member Jurisdictions between 2014 and 2018. (98)

	Jurisdiction	Total Acreage of Jurisdiction w/o bodies of water #	Acres of Tree Canopy 2014	Acres of Tree Canopy 2018	% Tree Cover 2014	% Tree Cover 2018	Acres of Tree Canopy Gain/Loss
1	Arlington County, VA	16,638.28	5,647.7	5,655.3	33.9%	34.0%	7.6
2	Charles County, MD	292,971.63	198,908.4	198,119.6	67.9%	67.6%	788.9
3	Fairfax County, VA	250,252.38	140,120.1	139,299.2	56.0%	55.7%	821.0
4	Frederick County, MD	422,776.31	179,592.1	181,709.0	42.5%	43.0%	2,116.8
5	Loudoun County, VA	330,071.15	147,938.1	145,075.4	44.8%	44.0%	2,862.7
6	Montgomery County, MD	315,589.05	153,264.0	147,479.5	48.6%	46.7%	5,784.4
7	Prince George's County, MD	308,890.48	168,099.1	160,808.4	54.4%	52.1%	7,290.7
8	Prince William County, VA	214,563.21	122,543.7	121,310.1	57.1%	56.5%	1,233.6
9	City of Alexandria, VA	9,558.58	2,639.3	2,658.1	27.6%	27.8%	18.8
10*	District of Columbia	39,120.61	15,235.8	14,760.3	38.9%	37.7%	475.5
11	City of Fairfax, VA	3,993.88	1,636.5	1,626.6	41.0%	40.7%	9.9
12	City of Falls Church, VA	1,309.72	541.1	536.4	41.3%	41.0%	4.6
13	City of Manassas, VA	6,299.49	1,502.4	1,498.9	23.8%	23.8%	3.5
14	City of Manassas Park, VA	1,941.63	426.0	424.6	21.9%	21.9%	1.4

Jurisdiction acreage w/o bodies of water data from Census Tiger Data and COG
* Independent Canopy Analysis using 2020 data by PlanIT Geo LLC in 2021

The Need for Regional Collaboration

The actions of one jurisdiction have the potential to impact the quality, health, and functionality of urban forests across the entire COG region. Tree diseases, insects, invasive plants, and deer populations do not observe jurisdictional boundaries. When serious threats are not adequately managed in one jurisdiction they can easily spread; even when adjacent jurisdictions are devoting adequate resources to address threats within their own boundaries.

Regional collaboration has the potential to produce synergistic results that are not obtainable by the efforts of individual communities, organizations, or programs through the sharing of ideas and resources and increased economies of scale.

Regional Tree Canopy Subcommittee

At present, COG's Regional Tree Canopy Subcommittee (RTCS) is the only governmental workgroup that has been formed to address the need for regional collaboration on matters relating to tree conservation and management. The COG Board chartered RTCS in 2019 in response to recommendation contained in the Tree Canopy Management Strategy published by COG in May 2018. RTCS reports to the Climate, Energy, and Environment Policy Committee (CEEPC) and was charged with developing strategies, tactics and recommendations that can be used to conserve and manage regional tree and forest resources in support of environmental, land use planning, regulatory, and socio-economic goals.

The COG Board and CEEPC has directed RTCS to produce two key sets of recommendations:

1) Develop a set of Regional Tree Canopy Goals and related metrics to track progress

RTCS recommendations are presented in Part 2 of this publication entitled "**Tree Canopy Goals for the Metropolitan Washington Region.**"

The goals are presented as either a goal or a target goal. Goals are ongoing and communicate outcomes which will require long-term monitoring and careful planning at both local and regional levels, whereas target goals are intermediate and small-scale objectives that support the goals. Target goals support the overarching regional goal progressively by recommending canopy coverage levels at intermediate and smaller scales. Part 2 recommends three tiers of tree canopy recommendations as follows:

1. ***Regional Tree Canopy Goal:*** This is the ongoing and overarching goal that identifies the minimum percentage of tree canopy coverage recommended for the entire COG membership area. The timeframe covered is present day until 2050.

2. ***Intermediate Target Goals based on Population Density and Urbanization:*** This tier recommends tree canopy levels for different levels of human population and urbanization. These goals offered long-term guidance for communities as they increase or decrease in population and are designed to support the regional goal.

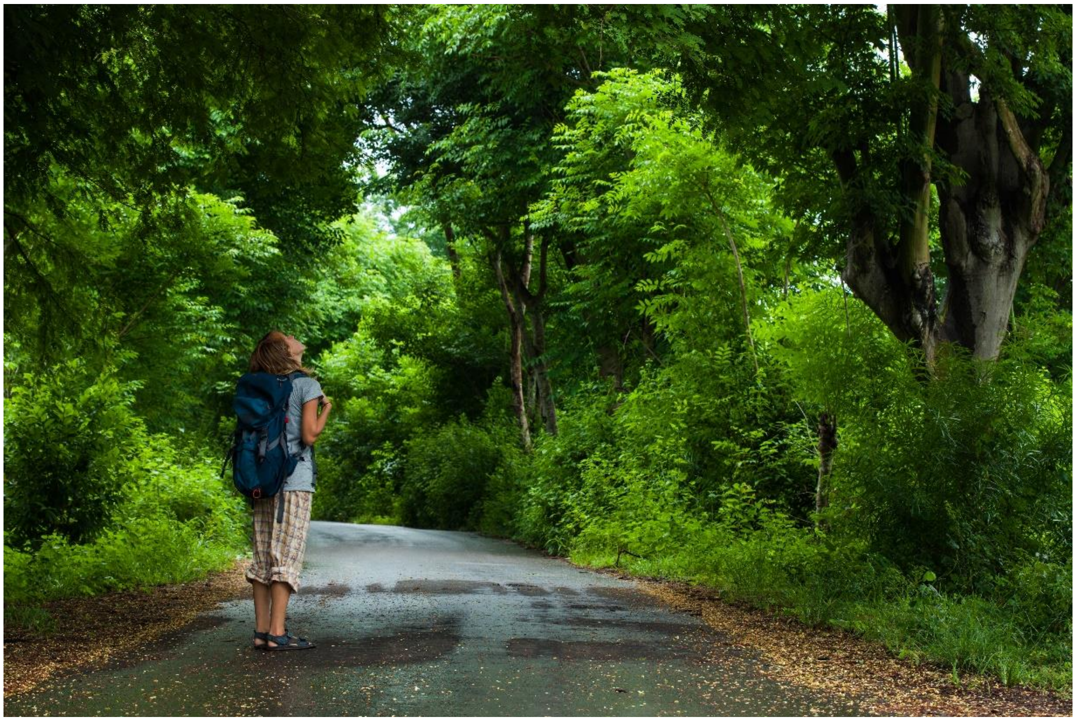
3. ***Smaller-Scale Target Goals Recommended for General Land Use Categories:*** This tier identifies canopy coverage levels for 18 general classes of land use that COG jurisdictions should find achievable on individual properties and in neighborhoods 40 years or more after initial land development has taken place.

All three goal tiers are intended to be adaptable and subject to periodic evaluation to allow for adaptation to changing conditions and/or unforeseeable influences and events. However, we believe the goals contained in this report are achievable and straddle a line between aspiration and pragmatism while balancing a wide range of socioeconomic, environmental, and ecological concerns.

The percentages of tree canopy coverage identified as goals and targets are intended as best management practices and general guidance. They are not intended to be used in a prescriptive fashion or construed as applicable to all situations. Just as individual jurisdictions must identify conservation objectives based on the unique set of conditions present within their boundaries; tree conservation objectives associated with the development of individual parcels must be determined on a site-by-site basis based on the unique set of conditions present at that time.

2) Develop a Regional Tree Canopy Action Plan

A regional tree action plan will help the region to respond to growth pressures and to implement the long-term vision and goals of local land use plans and Region Forward. Templates and examples provided by a regional plan could encourage a consistent approach to tree conservation and encourage continued interjurisdictional communication about common opportunities, challenges, and threats. This plan will help guide the development of shared outreach and marketing strategies used to engage a wider set of demographics, create neighborhood equity goals, and to form new partnerships. Collaborative efforts to implement the strategies and tactics contained in a regional tree action plan could help COG jurisdictions address regulatory requirements of the Clean Air Act and Chesapeake Bay water quality requirements.



PART 2: TREE CANOPY GOALS FOR THE METROPOLITAN WASHINGTON REGION

The intent of the regional tree canopy goal and supporting recommendations is to improve the quality of life and levels of public health and economic vitality enjoyed in the metropolitan Washington region by inspiring COG jurisdictions to protect and manage the vitality and safety of their tree and forest assets. For purposes relating to this report, the recommendations are expressed as the overarching ***regional goal*** or subsequent ***target goals*** that cover the same time period addressed COG's Regional Forward Vision (present to 2050).

1. ***Regional Tree Canopy Goal:*** This is the ongoing and overarching goal that identifies the minimum percentage of tree canopy coverage recommended for the entire COG membership area. The timeframe covered by this goal is present day until 2050.

2. ***Intermediate Scale Target Goals based on Population Density and Urbanization:*** This section identifies intermediate scale target goals to help COG communities set and monitor tree canopy goals for intermediate sized areas such as political sub-boundaries, watersheds, planning districts, census tracts, or even entire jurisdictions within the COG region.

3. ***Smaller Scale Target Goals Recommended for General Land Use Categories:*** This section identifies the average level of tree canopy coverage associated with 18 general classes of land use categories located within the COG region, along with mature canopy levels that COG

jurisdictions should find achievable on developed properties 40 years or more after initial land development has taken place. Both sets of information are presented in Table 9, on page 68.

Tree canopy coverage is widely used because the underlying concept is easily communicated, and highly useful for setting goals and tracking progress; however, it should not be regarded as the perfect measure of tree conservation efforts. It is a two-dimensional concept that does not communicate other important features of trees and forests such as their health, diversity, or sustainability. Nor does it measure how these natural features impact the quality of our lives and well-being (Part 2, Section 6, *Metrics of Success* describes other metrics that can be used for these purposes).

Intended Use. All three tiers of canopy goals described in this report represent fluid goals and objectives that are meant to be periodically evaluated to allow tree canopy planners to adapt to changing conditions and/or unforeseeable influences and events. The percentages of tree canopy coverage recommended in this report should be regarded as best management practices. They are not intended to be applied in a prescriptive fashion or to be interpreted as universally applicable to every scenario. Just as individual jurisdictions must identify conservation objectives based on the unique set of conditions present within their geographic boundaries; determining what the optimal level of tree canopy is for any property or geographic area must be addressed on a site-by-site basis and based on the set of conditions observed at that time.

The percentages of tree canopy coverage recommended in this report should be regarded as best management practices. They are not intended to be applied in a prescriptive fashion or to be interpreted as universally applicable to every scenario.

Terminology: "**Conservation**" is generally used to convey the wise use and management of a natural resource to prevent exploitation, destruction, or neglect so that both current and future generations can enjoy its products, services and benefits.

"**Tree conservation**" is used to describe the range of goals, strategies and practices that can be used to protect, manage and replenish trees and forests. In the context of urban tree canopy found within COG Jurisdictions this will include tree preservation, tree removal, tree planting, pest management, and arboricultural practices. In the context of forests this can include reforestation and afforestation, timber thinning and harvesting, pest management, and other practices aimed at keeping forested lands productive.

"**Tree canopy**" is used in this report to describe four general classes of land cover defined by a top-down view of the canopy associated with forests, woodlands, and individual trees. The classes reflect how tree canopy and areas located underneath canopy are detected and classified using remote sensing technologies. [(1)] The four classes (described below) are part of 50 unique classes used to delineate land use/land cover in the Chesapeake Bay Watershed by the Chesapeake Bay Program Land Use/Land Cover Project (CBP 2022 LULC Project).

Section 1: The Regional Tree Canopy Goal and Supporting Recommendations

When formed in 2019, COG's Board of Directors and CEEPC directed RTCS to recommend a *Regional Tree Canopy Goal* and canopy levels for major categories of land use; and, to develop a *Regional Urban Forest Action Plan* (Regional Tree Action Plan) to help guide and integrate local forest management plans and initiatives. In response, RTCS developed three tiers of canopy goals that include an overall level of tree canopy for the entire COG landmass; target goals for intermediate-sized areas based on density of human population and urbanization, and smaller scale target goals for 18 categories of land use. RTCS also recommends metrics that can be used to monitor and gauge the success of tree conservation goals and objectives.

Although, COG jurisdictions should find the intermediate and smaller scale goals useful in the context of local planning and policy deliberations, we anticipate that the Regional Canopy Goal will be more useful addressing matters that transcend jurisdictional boundaries such as regional air quality, water quality, and climate resiliency plans. RTCS also anticipates that the regional canopy goal will help strengthen local government tree conservation programs and non-profit conservation organizations by providing a central focus and shared visions.

The Regional Tree Canopy Subcommittee recommends adopting an overarching goal of ensuring at least 50 percent tree canopy coverage for the entire COG region through 2050

This goal represents the level of tree canopy RTCS recommends that COG jurisdictions strive to reach and maintain through 2050 (the same timeframe covered by COG's *Regional Forward* Vision).

A 50 percent tree canopy goal likely represents the ceiling of what is practical to achieve within the COG region. Setting the goal at this level:

- Straddles the line between aspiration and pragmatism.
- Is compatible with a wide range of socioeconomic, environmental, and ecological concerns.
- Strikes a balance between enjoying the benefits and managing the risks of tree canopy.

How the Regional Tree Canopy Goal was Determined

RTCS's recommendations are based on the following data, observations, and conclusions:

All three tiers of canopy goals, including the proposed Regional Tree Canopy Goal were derived from analyses of 2014 and 2018 tree canopy and land use and landcover data provided in the CBP 2022 LULC Project supplemented with local zoning designation maps, local comprehensive land use data and local natural resource protection and management plans. The CBP 2022 LULC Project data were used to examine land cover changes and trends in the COG land area using one-meter resolution, four-band (R, G, B, NIR) National Agriculture Imagery Program (NAIP) satellite imagery and LiDAR data (data acquired using "light detection and ranging" or "laser imaging, detection, and ranging" technology). These data delineate 50 classes of land use/land cover including 4 general classes of tree canopy that occurred between 2014 and 2018.

According to CBP 2022 LULC Project data tree canopy covered 51.3 percent of the combined land area of COG jurisdictions in 2014 and 50.6 percent in 2018 (based on the combined area of four classes of tree canopy subtracted from the combined land area of COG jurisdictions minus bodies of water). The amount of canopy lost between those four years equates to approximately 17,133 acres. These data indicate that the COG region lost an average of 4,383 acres of tree canopy each year during that four-year period and suggest that the current (2023) level of regional tree canopy is 49.6 percent.

Table 1. Tree Canopy Gain/Loss within the Metropolitan Washington Council of Governments Member Jurisdictions between 2014 and 2018.

	Jurisdiction	Total Acreage of Jurisdiction w/o bodies of water#	Acres of Tree Canopy 2014	Acres of Tree Canopy 2018	% Tree Cover 2014	% Tree Cover 2018	Acres of Tree Canopy Gain/Loss
1	Arlington County, Virginia	16,638.28	5,647.7	5,655.3	33.9%	34.0%	7.6
2	Charles County, Maryland	292,971.63	198,908.4	198,119.6	67.9%	67.6%	788.9
3	Fairfax County, Virginia	250,252.38	140,120.1	139,299.2	56.0%	55.7%	821.0
4	Frederick County, Maryland	422,776.31	179,592.1	181,709.0	42.5%	43.0%	2,116.8
5	Loudoun County, Virginia	330,071.15	147,938.1	145,075.4	44.8%	44.0%	2,862.7
6	Montgomery County, Maryland	315,589.05	153,264.0	147,479.5	48.6%	46.7%	5,784.4
7	Prince George's County, Maryland	308,890.48	168,099.1	160,808.4	54.4%	52.1%	7,290.7
8	Prince William County, Virginia	214,563.21	122,543.7	121,310.1	57.1%	56.5%	1,233.6
9	City of Alexandria, Virginia	9,558.58	2,639.3	2,658.1	27.6%	27.8%	18.8
10*	District of Columbia	39,120.61	15,235.8	14,760.3	38.9%	37.7%	475.5
11	City of Fairfax, Virginia	3,993.88	1,636.5	1,626.6	41.0%	40.7%	9.9
12	City of Falls Church, Virginia	1,309.72	541.1	536.4	41.3%	41.0%	4.6
13	City of Manassas, Virginia	6,299.49	1,502.4	1,498.9	23.8%	23.8%	3.5
14	City of Manassas Park, Virginia	1,941.63	426.0	424.6	21.9%	21.9%	1.4

Source: 2013/2014 and 2017/2018 CBP LULC tree canopy data published in 2022.
Jurisdiction acreage w/o bodies of water data from Census Tiger Data
* Independent Canopy Analysis using 2020 data by PlanIT Geo LLC in 2021

Table 2 identifies detected canopy levels for 2014 and 2018 along with projected levels for 2022, 2023, 2026 and 2030. It should be noted that the projected trendline shown in Table 2 is limited to change that occurred between two data points spaced four years apart and may have limited value predicting trends beyond a few years. A more accurate trendline will become available when the Chesapeake Conservancy reports 2022 land use/land cover data, which is expected to occur in 2025.

Table 2. Actual and Projected Canopy Losses Between 2014 and 2026

Year	2014 (actual)	2018 (actual)	2022 (projected)	2023 (projected)	2026 (projected)	2030 (projected)
Acreage of Tree Canopy	1,136,496.9	1,119,363.9	1,102,230.9	1,097947.9	1,085,097.7	1,067,964.5
Percent of COG landmass covered by tree canopy	51.3%	50.6%	49.8%	49.6%	49.0%	48.1%

Source: 2013/2014 and 2017/2018 CBP LULC tree canopy data published in 2022. Projected canopy coverages are based on linear projection of actual canopy losses detected between 2014 and 2018.

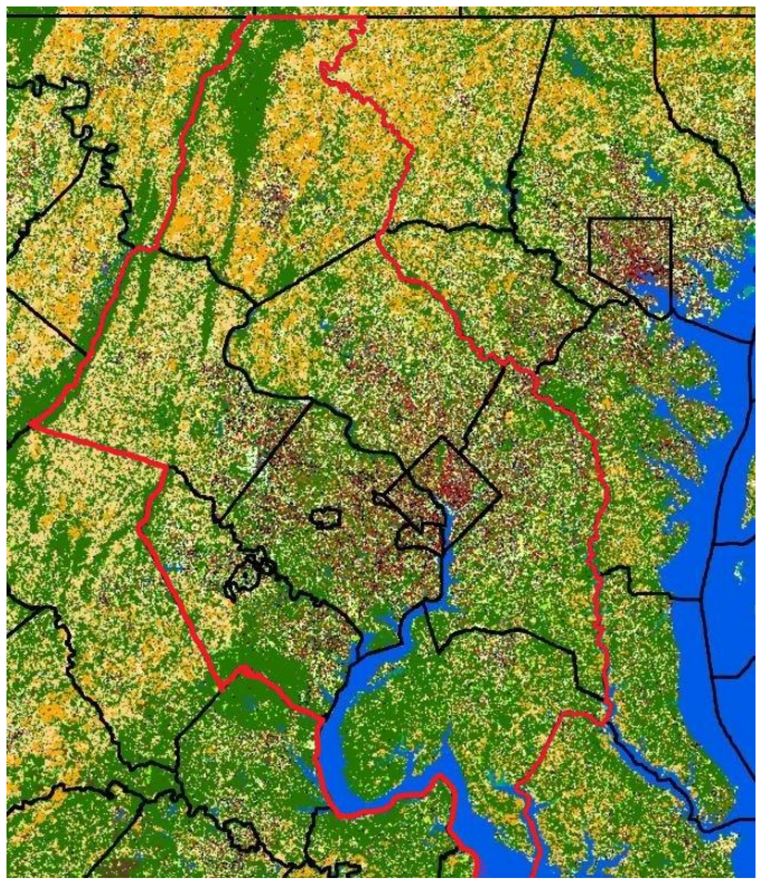
The Regional Goal is Realistic based on Current Conditions. A 50 percent tree canopy goal is almost identical to the level of tree canopy detected in 2018 (50.6 percent). Although the current canopy level for the COG region may have dropped below 50 percent since that year (see Table 2), the similarity underscores that the proposed Regional Goal and smaller-scale target goals are achievable because they are based in the current realities and limitations imposed by environmental and climatic conditions, land use patterns, societal values, and levels of regulatory authority found in the COG region. However, the proposed Regional Goal and supporting strategies and action plans will need to be carefully monitored and may need to be adjusted periodically to address changing conditions.

50 percent Canopy Coverage represents 1.11 million acres of tree canopy distributed throughout 2.21 million acres of the combined landmass of COG jurisdictions. This amount of canopy should provide similar levels of public health, socioeconomic, environmental, and ecological services to those provided by trees and forests in 2018; however, land cover changes could alter the type and level of tree services provided at specific locations in the future.

50 percent Tree Canopy Coverage is similar to that found elsewhere in the Eastern United States. A national analysis by the U.S. Forest Service found that 40 percent to 60 percent urban tree canopy is attainable under ideal conditions in forested states. Overall urban tree cover in the United States circa 2014 averaged 39.4 percent of the total land area with tree cover in urban/community areas averaging 42.2 percent. Tree cover varies by state, with urban tree cover highest in Connecticut (61.6 percent), Georgia (58.8 percent), Maine (58.5 percent), Massachusetts (57.1 percent), and New Hampshire (56.3 percent); and lowest in North Dakota (10.1 percent), Wyoming (11.9 percent), Nevada (12.9 percent), Idaho (13.1 percent), and Utah (14.9 percent). In the Mid-Atlantic region, the urban tree cover in Maryland averaged 53.1 percent and Virginia averaged 51.0 percent. [99]

Using these data as points of reference and considering the extent of urbanization that has occurred in metropolitan Washington region the RTCS concluded that supporting the upper range of **urban tree canopy identified in the 2014 national analysis (55 to 60 percent) was not feasible given the possible land development that could occur in the COG region over the next quarter of a century.** However, a detailed analysis of CBP 2022 LULC Project data, local comprehensive land use plans, transportation plans, local zoning maps, regional population projections and green infrastructure plans suggested that **it is feasible to support tree canopy coverage in the 45 to 50 percent range over the next 25 years,** and possibly more if COG jurisdictions take steps to implement the tree conservation strategies outlined in this report.

The likelihood of successfully engaging the public appears more viable than ever due to public awareness and concern regarding the impacts of climate change, which some are calling an existential threat to our species. (100). Supporting a 50 percent tree canopy goal will require developing effective public-private partnerships and instilling a sense of goal ownership in private citizens via civic associations, private institutions, and non-profit organizations. Forming and maintaining these partnerships is likely to be one of the most challenging aspects of the regional goal.



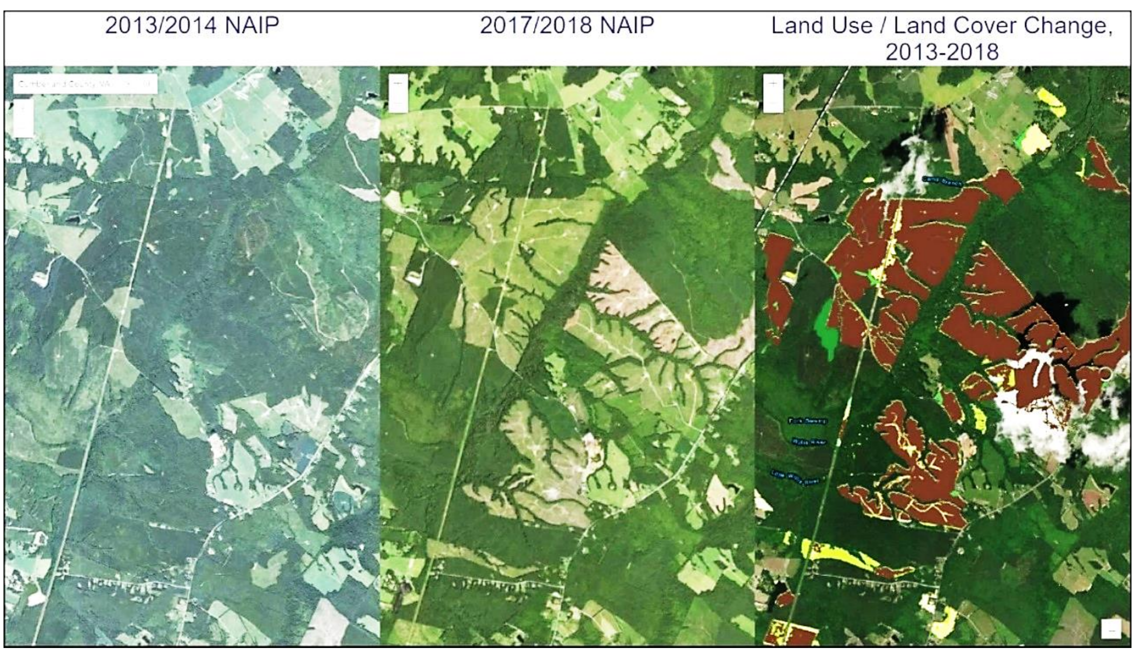
Web image: Chesapeake Conservancy

Tree Canopy Losses are Not Inevitable and Can be Reversed. Tree canopy gains and losses in the Metropolitan Washington region have swung dramatically over the last two centuries and have not always followed the narrative that urbanization decreases tree canopy.(101) To the contrary, the urbanization of non-forested areas can actually result in overall canopy gains over time.(102) In addition, natural succession of vegetation located on vacant and underutilized properties and the regrowth of recently harvested forests can have a substantial influence on overall tree cover levels.(102) Both of these phenomena have influenced canopy gains within the COG region in the past and are likely to do so in the future. For example, a recent analysis of 2018 CBP 2022 LULC Project data indicates that areas classified as “Successional Vegetation” or classified as “Recently Harvested” forest have potential to add as much as 40,000 to 50,000 acres of early successional tree canopy to the COG Region.

The trendline based on tree canopy losses detected between 2014 and 2018 suggests that canopy levels will remain between 45 and 50 percent until the year 2048 and then drop to 44.4 percent by 2050. However, this trendline is based on only two data points; therefore, it has limited value in forecasting long-range trends. Forecasting impacts to trees and forests over a quarter of a century is very challenging. A host of variables must be considered including land development trends, housing and transportation needs, reforestation efforts, effects of climate change, large-scale storm damage, outbreaks of diseases and forest pests, societal shifts, and economic swings. Given the potential for unpredictable change and unforeseeable events to influence canopy gains and losses, it should become apparent that the regional canopy goal is not the be-all and end-all of efforts to conserve trees and forests. The accuracy of the recommended percentage of tree canopy may ultimately prove less valuable than the journeys and lessons learned while striving to reach and maintain it.

Given the aforementioned considerations, we recommend that all three tiers of canopy goals are monitored and reevaluated once every five-years to allow for adaptation to changing conditions and unforeseeable events. A five-year re-evaluation cycle dovetails with current plans by the Chesapeake Conservancy to acquire new satellite imagery and LiDAR data at four-year intervals and to continue using this data to map land use/land cover changes, including changes to four classes of tree canopy that occurred between satellite imagery/LiDAR acquisition dates. Having access to additional change detection data every five years will provide a more accurate glimpse into canopy gain/loss trends at both local and regional scales, along with a better understanding of the magnitude of effort and resources that would be needed to support a regional goal.

We should all understand that the regional canopy goal is not the be-all and end-all of efforts to conserve trees and forests. The accuracy of the percentage of canopy coverage associated with goal success may ultimately prove less valuable than the journeys taken while striving to reach and maintain it.



This image illustrates part of the change detection process used in the 2018 CBP 2022 LULC Project. (United States Geological Survey)

How COG Jurisdictions Could Support the Proposed Regional Goal

To support the Regional Goal, COG member jurisdictions will likely need to implement actions like those summarized below which are explained in more detail further in this section:

- Use intermediate and smaller-scale goals to support the regional canopy goal and local climate action plans
- Build on the success of current tree canopy goals, ordinances, and programs
- Adopt local tree actions plans
- Embed tree conservation objectives in local land development criteria language
- Encourage the preservation of existing tree and forests during by-right and in-fill development
- Implement and support large-scale tree planting programs
- Support programs to manage the impacts of climate change, excessive herbivory, invasive plants, and other disturbance regimes on forest and woodland communities
- Increase public outreach and education
- Build partnerships among stakeholders
- Act collaboratively on tree and forestry matters of mutual concern
- Enact programs to encourage the preservation of forests and trees through deed restrictions, conservation easements, environmental protection overlay districts, transfer of development rights, etc.
- Assess the capacity of local government tree programs

Use Intermediate and Smaller-Scale Target Goals to Support the Regional Canopy Goal and Climate Action Plans

The ***Intermediate Target Goals based on Population Density and Urbanization*** (Part 2, Section 4) and ***Smaller-Scale Target Goals Recommended for Land Use Categories*** (Part 2, Section 5) were designed to help COG jurisdictions guide local tree preservation and planting activities during the entire time period addressed by the Regional Goal (present to 2050). These smaller scale goals and targets reflect a "***take care of the pennies and the dollars will take care of themselves***" approach to achieving and sustaining the regional goal. The US Forest Service Publication "*The Sustainable Urban Forest: A Step-by-Step Approach*" reflects on this same approach.

"*The distribution of tree canopy cover is generally not – and needn't be – uniform across a municipality or even identical in every neighborhood. A single overarching canopy goal has its merits; for one thing, it is easier to communicate and promote. But at a functional level, it's more important to break that down into more meaningful pieces, through a finer-scale analysis – by census tract, parcel, land ownership, sub-watershed, or other boundaries or land-use designations.*" (102)

The intermediate target goals associated with density of human population and degree of urbanization identify canopy coverage levels recommended for intermediate-sized areas such as individual jurisdictions, watersheds, and census blocks. These recommendations can be used to evaluate the impacts of jurisdictional growth and land use change on canopy levels along with the relative effectiveness of tree conservation efforts. The smaller scale target goals identify mature canopy coverage levels for 18 general classes of land use that COG jurisdictions should find achievable on individual properties and in neighborhoods 40 years or more after initial land development has taken place.

Build on the Success of Current Tree Canopy Goals, Ordinances and Programs

Many COG Jurisdictions have already adopted or are in the process of adopting local Tree Canopy Goals, tree-related management plans, ordinances and programs, and can use these guidelines to support a regional tree canopy goal and specific objectives. **The appendix contains a list of examples of current Tree Canopy Goals and Tree Conservation Programs found in the metropolitan Washington region**

Adopt Local Tree Action Plans
The purpose of having a local tree action plan is to ensure that a community can enjoy the service and benefits of trees and forests through public engagement, use of industry-accepted tree care, and forest management practices. These plans can be used to provide a technical framework that supports tree canopy goals and to identify what is needed to manage the community's tree canopy. A local tree action plan is more likely to instill a sense of "ownership" in the community if it is developed with input from governmental agencies, arboricultural experts, and citizens groups.

Embed Tree Conservation Objectives in Local Development Criteria Language

COG jurisdictions should evaluate if the criteria used to evaluate land development proposals contain language that encourages developers to maximize tree preservation and planting opportunities. This action will help ensure that tree conservation is included in early planning and site layout stages of development processes, as opposed to treating opportunities to preserve and plant trees as an afterthought in the final engineering stage when site design and layout has already been largely determined.

Encourage the Preservation of Existing Tree and Forest Canopy During By-right and In-fill Development

COG jurisdictions should evaluate if their local tree regulations take full advantage of opportunities to preserve existing trees in a healthy and safe manner as part their by-right land development review and enforcement processes. This may prove especially valuable in the context of infill development and redevelopment of older communities where CBP 2022 LULC Project data indicates significant levels of canopy loss occurred between 2014 and 2018. [(1)] Although preserving the volume of soil and roots that trees need to survive and thrive in the post-development environment can be challenging, when successful these efforts are likely to be rewarded with the immediate delivery of tree-related services and benefits. Research by the USDA Forest Service demonstrates that large healthy trees greater than 30 inches in diameter can remove as much as 60 to 70 times more air pollution annually (3.1 pounds/ year) than small healthy trees less than 3 inches in diameter (0.05 pounds/year). [(103)]

COG's publication ***The Tree Conservation Cookbook: Essential Recipes for Tree Canopy Preservation and Enhancement in the Metropolitan Washington Region*** provides guidance efforts to strengthen tree-related policies and ordinances, practices and policies, and highlights regulatory concepts and technical language that are associated with effective tree conservation programs. "The Cookbook" helps the reader target example ordinance language that originates from communities similar in terms of population density, land use, demographics, and tree canopy composition. The Tree Conservation Cookbook is available here: Tree Conservation Cookbook.

Implement and Support Large-Scale Tree Planting Programs

COG jurisdictions will benefit from implementing large-scale tree planting programs that include effective public outreach programs capable of inspiring a sense of ownership in neighborhood tree planting efforts. Most opportunities to increase tree canopy via tree planting are likely to occur on privately-owned residential properties, especially those developed on previous agricultural lands. In urbanized areas of the United States, the land uses with the highest proportion of planted tree canopy are residential (74.8 percent of trees were planted) and commercial/industrial lands (61.2 percent of trees were planted). (104) Properties zoned low density residential or as rural residential currently comprise 40 percent or more of the landmass of the inner and outer suburbs. Jurisdictions are advised to analyze local aerial imagery, land use, and zoning data in conjunction with CBP 2022 LULC Project data to identify potential tree planting sites, and to target demographic groups for outreach programs. The following list provides potential ways to increase canopy levels through tree planting:

- in low-density residential neighborhoods, especially in common open space and conservation easements,
- on large public, institutional, and corporate properties through private and public planting programs and incentives,
- in lower income neighborhoods to help address environmental equity through tree planting and maintenance programs,
- on abandoned or underutilized lots and easements through conservation easements, incentives, and planting programs,
- to reduce Urban Heat Island Effects by prioritizing conservation and strategic tree planting in high heat areas,
- to offset fossil fuel energy used to heat and cool buildings through strategic tree planting and preservation on the western and southwestern sides of buildings,
- to improve water quality by preserving and replanting riparian corridors and using trees to address water quality regulations,
- as a tree planting and/or conservation program on private property, and
- to establish “no mow” zones on public and private lands to facilitate natural succession to forest and woodland communities.

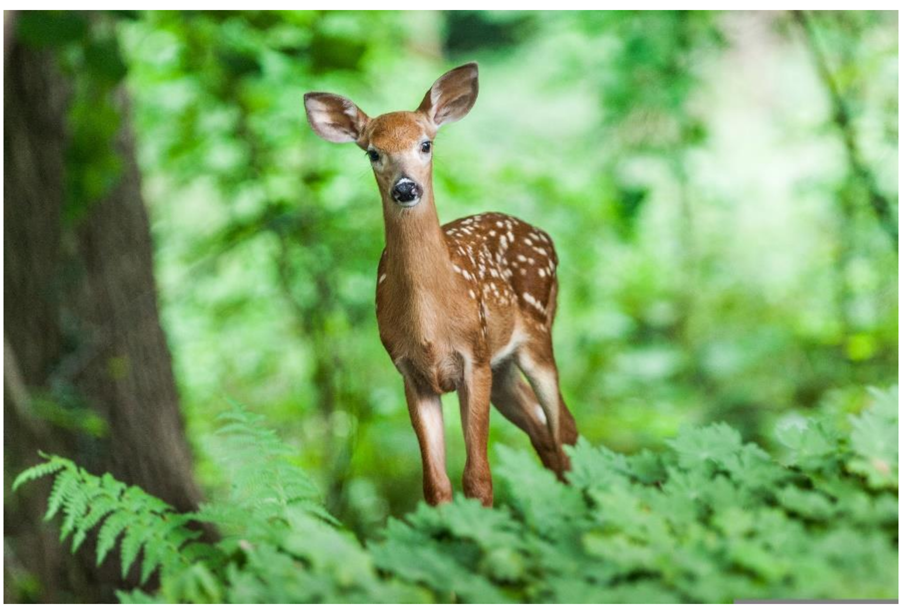
These types of projects must be methodically planned and carefully implemented to be successful. Indiscriminately “carpet bombing” areas with low canopy levels without adequate planning and preparation can create as many problems as new trees are intended to solve. Early planning stages of projects should identify the intended functionality of the new trees (e.g., energy conservation, water quality improvements, increasing retail traffic, etc.). A concerted effort should be made to only use species and planting sizes that can withstand the range of soil, moisture and environmental conditions that will be encountered at planting sites, and to use industry accepted best management practices that have been proven to produce healthy and structurally sound trees. Early planning stages should also identify the financial resources and maintenance practices that will be needed to ensure that new trees will survive and become established.

When carefully planned, tree planting projects can provide numerous public health, environmental and socioeconomic benefits to the surrounding community. A study conducted by the U.S. Forest Service estimates that $3.74 is returned on every dollar invested in the planting and care of trees typically planted in our region (105) and that that the benefits provided by urban trees in the piedmont region of the United States typically outweigh their costs. However, a benefit to cost ratio tipping point is likely to vary significantly from one site to another depending on the degree of urbanization, composition of land uses, composition of tree species, climate and density of human population so careful planning and implementation of tree planting projects cannot be overstressed.

Support programs to detect and manage the impacts of climate change, excessive herbivory, invasive plants, and other disturbance regimes on our native forest and woodland communities

Our native forests and woodlands are currently under unprecedented stress from abrupt shifts in disturbance regimes that are linked to climate change. These disturbances include wildfire suppression, (106) decimation of major species following outbreaks of non-native insects and diseases, (107) wide-spread establishment of invasive plants, (108) and historically high herbivory (defoliation by deer and other organisms). (109) Any of these disturbances have potential to substantially disrupt the health and sustainability of our forest and woodland communities along with their capacity to deliver ecosystems services (e.g., human health benefits and improvements to water and air quality).

As one manifestation of biological invasion, invasive alien or non-native plant species represent a major threat to global and local biodiversity. Invasive plant species cause widespread negative impacts on forest regeneration by affecting seedling and sapling abundance and diversity. (110) The composition of future forest communities may be highly influenced by invasive plants. (111) Biological invasions, (including those associated with invasive plant species) are a leading cause of global environmental change because of their effects on both humans and biodiversity. (112) Invasive and alien species can alter ecosystem services, livelihoods, and human well-being. (113)
Damage from overly populated white-tail deer and invasive plants are particularly problematic stressors of forest communities in the Mid-Atlantic region. (114) Although many COG member jurisdictions fund programs to suppress populations of more injurious insect pests such as Gypsy Moth and Emerald ash borer, efforts to check deer populations and the spread of invasive plant species such as Microstegium vimineum and Wavyleaf basketgrass have only met limited success.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Healthy deer density is considered to be 10 deer per square mile by many wildlife biologists, ecologists, and environmental professionals. (115) Forest ecology suffers tremendously from deer over-browsing. (116) Impacts to the forest understory become harmful when deer population densities surpass 20 deer per square mile, and greater levels of browsing begin to impede forest regeneration. (117) Areas with deer densities that surpass this threshold are associated with higher levels of invasive plants, depleted habitats for birds and other organisms that consume ticks, and higher rates of starved and diseased deer. The long-term impacts of these disturbances are difficult to predict; however, it is reasonable to expect they could begin affecting the species composition and structure of forested areas within a few decades, along with the way human beings perceive, value, and interact with nearby trees and forests.

Building Partnerships

COG jurisdictions will need to establish strong partnerships with non-profit conservation and tree planting organizations and other public and private entities. Non-profit environmental advocacy groups tend to be very effective at developing community outreach and educational programs, and encouraging local volunteers to take part in neighborhood tree planting and tree care projects. In addition, COG communities will need to engage for-profit businesses centered around tree care, forest management, plant propagation, and retail nursery sales. Other groups and organizations may include:

- State forestry departments
- Land management agencies
- Electric, gas, sanitation and water authorities
- Building industry associations
- Tree care trade organizations
- Landscape and nursery trade organizations
- Large private and institutional landholders
- Neighborhood action groups

Offsetting the average annual rate of canopy loss detected between 2014 and 2018 would require reforesting 4,300 acres of canopy in the COG region. If planting 2-inch caliper nursery stock trees were the only reforestation method used, it could require as many as 109,300 trees a year to offset the 4,300-acre loss. Fortunately, there are other tree products and practices available to establish tree canopy (e.g., smaller caliper nursey trees, saplings, seedlings, now mow zones and reforestation via natural succession). However, these figures associated with 2-inch caliper trees underscore the importance of building strong partnerships to ensure that large numbers of quality trees are available to plant each year, along with the capacity and interest to plant them.

Reaching and Sustaining the Regional Tree Canopy is likely to require forming robust partnerships with non-profit organizations dedicated to preserving and planting trees.

Some non-profits like the Casey Trees Foundation have established a nursery in Virginia to grow their own trees for use in their reforestation efforts.

Michael Knapp

Evaluate the Capacity of Local Tree Programs

COG jurisdictions will need to evaluate if their local tree programs have the capacity and resources needed to support local actions (e.g., tree planting, the review of land development plans, public outreach, etc.) that support the regional tree canopy goal. Such an evaluation should include a review of local staffing levels; the skills, knowledge, and abilities of staff; current and projected levels of funding; and the mission and scope of the local programs. In some cases, new programs may need to be authorized, funded, and staffed. Although updated CBP LULC Project data is likely to remain available for the foreseeable future, local governments may need to fund and conduct local canopy studies to address jurisdiction specific needs. In addition, new tree planting programs may require Geographic Information System software, training, IT support and equipment.

Instill a Sense of Ownership in the Public-at-large

COG member jurisdiction will not be able to support a regional tree canopy goal without engaging the public at large. **Most of the opportunities to increase and preserve tree canopy are located on privately owned lands.** Therefore, COG jurisdictions will need to inspire individuals and community-based groups alike to support local tree conservation goals and objectives. Community outreach programs will need to convey an appreciation of the services and benefits provided by trees and to instill a sense of “ownership” in the jurisdiction’s goals and objectives.

Act collaboratively on Matters of Mutual Concern

Widescale disturbances to trees and forests do not observe jurisdictional boundaries. When threats (severe weather, pests, diseases, invasive plants, overpopulated deer, etc.), are not adequately managed in one jurisdiction they can easily spread and affect the tree canopy of adjacent jurisdictions, even if those jurisdictions have devoted adequate resources to address threats within their own boundaries. To mitigate the potential for threats to cause widespread canopy damage and losses COG jurisdictions should take collective steps to monitor and assess their potential to threaten the sustainability of trees and native forests; and, when necessary, take collective action to address these concerns at the regional level.

It should be noted that since COG’s **Regional Tree Canopy Subcommittee** is comprised of regional subject matter experts that have been charged by the COG Board of Directors with “protecting, managing, and expanding urban forestry assets for health and quality of life.” Consequently, this group would be the most logical organization to task with this important function.

Section 2: Current Capacity of COG Jurisdictions to Support a Regional Goal

There are currently 24 jurisdictions that comprise the 2,382,149.4 acres of the combined COG landmass. To more effectively report on the capacity of the region to support an overarching canopy goal, COG jurisdictions have been grouped into one of three separate geographic units that reflect similar land use patterns and degrees of urbanization and require similar conservation practices. These groups are entitled *Core Jurisdictions*, *Inner Suburbs*, and *Outer Suburbs*.

COG Core Jurisdictions

- The Core Jurisdictions include the District of Columbia, Arlington County, and the City of Alexandria. **Geographic and land cover characteristics of the Core Jurisdictions**: The combined landmass of the Core Jurisdictions is 70,277.3 acres and represents 3.0 percent of the combined area of the COG region (2,382,149.4 acres).

- **Tree Canopy Trends:** The average percentage of tree canopy coverage in the Core Jurisdictions was 35.3 percent in 2018. This area of tree canopy represents 2.1 percent of total COG Tree Canopy. Although lower canopy levels are historically associated with high density uses within the Core Jurisdictions of Washington D.C., Arlington County and the City of Alexandria, these jurisdictions appear to be nearing their comprehensive land use plan potential and contain large areas of tree canopy located on local and Federal parkland and governmental facilities. The percentage of overall canopy loss that occurred between 2014 to 2018 was less than 2 percent, therefore we anticipate that tree canopy levels in these jurisdictions will remain relatively stable for the foreseeable future. Note: Without being addressed this trend may continue, but current canopy loss trendlines appear to be less severe than in the Inner and Outer Suburbs.

- **Major Environmental Services and Benefits:** The 23,073 acres of tree canopy that existed in the Core Jurisdictions in 2018 are calculated to have provided the following environmental services and monetary benefits:

	Level of Annual Service	Monetary Equivalent
Air Pollution Removal	1,577,101 pounds	$7,798,143
Stormwater Runoff Reduction	424,512,997 gallons	$3,795,095
Carbon Sequestration	29,271 tons	$5,293,103

Services and monetary equivalents are calculated based on 2018 tree cover data using i-Tree Landscape software. It should be noted that tree canopy provides many other environmental, ecological, human health and socioeconomic services and benefits than those reported above,

- **Programs:** All three Core Jurisdictions have effective local government tree conservation programs that oversee and monitor local tree canopy goals, long-term Urban Forest Management Plans, tree preservation and planting regulations, and public outreach efforts. For example, the Urban Forestry Division (UFD) is responsible for enhancing and protecting the District of Columbia's tree canopy. This includes issuing permits for the removal of special trees of the Urban Forest Preservation Act of 2002 and enforcing a prohibition on the removal of heritage trees. A *special tree* is one with a circumference between 44 inches and 100 inches, while a heritage tree is one with a circumference of 100 inches or larger. UFD determines whether a tree is hazardous, a species designated for removal, or, in the case of a special tree, if the applicant must pay into the Tree Fund. An applicant may also seek approval from UFD to relocate a heritage tree. UFD can issue a fine of at least $300 per inch of circumference for any unauthorized removal of a special or heritage tree.

In Virginia, Arlington County and the City of Alexandria have tree canopy regulations which require developers to demonstrate how they will provide a range of tree canopy coverages on site and development plans. The required percentage of canopy coverage is based on the zoning designation of the property being developed and projected at either 10 or 20-years after development takes place. The requirements can be met through tree preservation or planting and effectively protect and add thousands of trees to private property each year. These provisions are enabled through the Code of Virginia § 15.2-961. Replacement of trees during development process in certain localities.

- **Community Support:** All three jurisdictions are supported by tree planting and community outreach efforts of non-profit tree organizations such as the ***Casey Tree Foundation*** which is a well-known and very active non-profit organization dedicated to preserving and planting trees in the District of Columbia and advocates for trees at local, regional, and national levels.

Earth Sangha is a non-profit organization that operates a volunteer-based ecological restoration program in the Core Jurisdictions and Greater Washington D.C. region. Their program is designed to conserve and restore native plant communities. Their Wild Plant Nursery offers a large variety of native plants propagated from local, wild seed.

The goal of ***EcoAction, Arlington's*** **Tree Canopy Fund** is to increase Arlington County's tree canopy. Through this program citizens can request that large canopy trees be planted on their property. Since its inception, EcoAction Arlington has planted more than 5,000 trees.

Tree Stewards of Arlington and Alexandria are Northern Virginia volunteers who take the lead to enhance a sustainable urban forest through volunteer activities and public education programs. Their volunteer activities include tree planting and providing tree care for street, park, and school trees, leading neighborhood Tree Walks and advocating for trees at community gatherings and forums.

Table 3. Select Land Use/Land Cover Features of COG's Core Jurisdictions

CBP LULC Class	Acres in 2014	Acres in 2018	Percent of Core Jurisdiction 2018	Gain/Loss
Forest	5,796.4	5,690.3	8.71%	- 0.16%
Tree Canopy over Impervious	3,850.0	3,936.4	6.02%	+0.13%
Tree Canopy over Turf Grass	10,337.6	10,389.3	15.90%	+0.08%
Tree Canopy, Other	1,941.4	1,957.4	2.99%	+0.02%
Natural Succession	830.8	775.5	1.10%	- 0.08%
Turf Grass	8,874.2	8,870.4	12.62%	- 0.01%
Impervious Roads	10,135.7	10,085.9	14.35%	- 0.07%
Impervious Structures (Buildings)	9,681.9	9,762.9	13.89%	+0.12%
Impervious, Other	10,805.0	10,752.6	15.30%	- 0.07%

Source: 2013/2014 and 2017/2018 CBP LULC tree canopy data published in 2022.

- **Opportunities to Increase Canopy:** A preliminary analysis of 2018 CBP 2022 LULC Project data and zoning designation maps indicates there may be significant opportunities to increase tree canopy in Core Jurisdictions by planting trees:
  - ✓ along streets, in parks and other governmental facilities
  - ✓ on large public, institutional and corporate properties
  - ✓ in lower income neighborhoods to help address environmental equity
  - ✓ on abandoned or underutilized lots and easements
  - ✓ on private property where viable opportunities exist
  - ✓ to reduce Urban Heat Island Effects and the impacts of climate change
  - ✓ to offset fossil fuel energy used to heat and cool buildings
  - ✓ in stormwater management facilities and adjacent to bodies of water to improve water quality and flood control

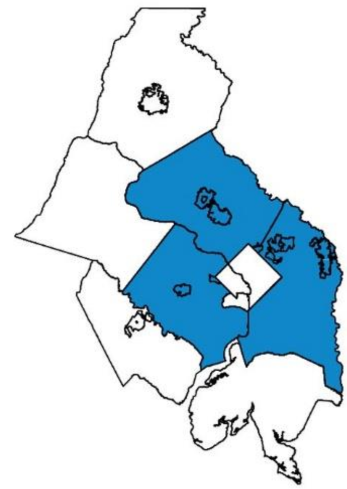
Tree planting projects implemented in high density urban areas should be methodically planned. Not doing so can create as many problems as the new trees are intended to solve. The unintended consequences of poor planning can include increased need to prune and remove trees for overhead utility clearance; unnecessary damage to underground utilities and pavements; blocking traffic sight distance, road signage, and pedestrian access; and increased emissions from fossil fuel-based tree care equipment, etc.

- **Challenges:** Where feasible, efforts to preserve existing trees should take precedence over tree planting; however, tree preservation can be very challenging in areas that have been highly developed and lack open space. Decisions to preserve trees in urbanized areas must be based on the realities and limitations imposed by tree biology, and not on public opinion - otherwise the trees retained on development sites may develop into liabilities rather than assets.

COG Inner Suburbs

- The Inner Suburbs include Fairfax County, Montgomery County and Prince George's County plus multiple municipalities embedded within these counties. **Geographic and land cover features of the Inner Jurisdictions**: The combined landmass of the Inner Suburbs is 881,313 acres. This area represents 39.8 percent of the combined landmass of COG jurisdictions.

- **Tree Canopy Trends**: The average tree canopy coverage in the inner suburbs is approximately 51.03 percent. This area of tree canopy represents 40.1 percent of total COG tree canopy. A significant amount of tree canopy located in the Inner Suburbs is legally protected from removal by means of local, state, or federal regulations or by deed restriction. These areas include flood plains; natural resource protection areas; forest conservation areas, watershed protection districts; conservation easements; and local, regional, state and Federal parklands. In addition, the Inner Suburbs contain large areas zoned for low-density residential use, which averages 52 percent tree canopy and has high potential to host 55 percent or more tree canopy through tree planting and tree care programs on private lots and common open space.



- **Major Environmental Services and Benefits:** The 449,750 acres of tree canopy that existed in the Inner Suburbs in 2018 are calculated to have provided the following environmental services and monetary benefits:

	Level of Annual Service	Monetary Equivalent
Air Pollution Removal	32,000,000 pounds	$66,508,000
Stormwater Runoff Reduction	3,893,102,761 gallons	$35,441,298
Carbon Sequestration	572,640 tons	$107,300,000

Services and monetary equivalents are calculated based on 2018 tree cover data using i-Tree Landscape software. It should be noted that tree canopy provides many other environmental, ecological, human health and socioeconomic services and benefits than those reported above.

- **Programs:** The Inner Suburbs have relatively strong tree conservation laws. Both Montgomery and Prince George's Counties have local laws based on Maryland Forest Conservation Act (FCA), which was designed to minimize the loss of forest resources during land development by making the identification and protection of forests and other sensitive areas an integral part of the site planning process. According to the Maryland Department of Natural Resources, during the first fifteen years of implementation, the FCA has been responsible for the review of 199,925 acres of forest on projects scheduled for development. Of those, 120,638 acres were retained, 71,885 acres were cleared, and 21,461 acres were planted with new forest. In other words, at least twice as many acres were protected or planted as were cleared.

Prince George's County local Woodland Conservation Ordinance (WCO) served as a model for the Maryland Forest Conservation Act. When it was first introduced in 1990, the WCO was groundbreaking in the State of Maryland and nationally. It provided, for the first time, direction, and requirements for preserving trees and woodlands during land development processes. The name of the ordinance was changed to the Woodland and Wildlife Habitat Conservation Ordinance in 2010 to emphasize that wildlife habitat conservation is one of the purposes of the regulations.

In March 2023, the Montgomery County Council passed ***Bill 25-22, (Forest Conservation)*** , which amended 22A of the Code of Montgomery County to achieve greater forest planting and forest conservation in Montgomery County with a goal of achieving an equal or greater area of forest planted than forest removed on a countywide level by projects subject to the Montgomery County Forest Conservation Law. The amendments were a product of Montgomery Planning's No Net Loss of Forest Initiative, seeking to achieve equal or greater area of forest planted than forest removed on a countywide level, by projects subject to the Montgomery County Forest Conservation Law, while also allowing development to continue moving forward.

In addition to Chapter 22A, Montgomery County has two other tree conservation laws. Chapter 55 of the Montgomery County Code entitled ***Tree Canopy Conservation*** requires land developers to plant new shade trees to offset the impacts of development on the natural environment. It is applicable to any activity that requires a sediment control permit. The law allows developers to pay fees in lieu of planting trees on development sites. Montgomery County places those fees into a fund that is used to plant trees in other locations. The second law, entitled the ***Roadside Trees Protection Law*** was enacted in 2013 to protect publicly owned trees growing in County rights of ways from construction and maintenance activities that occur within the Critical Root Zone. It is administered through the review of right-of-way use permit applications and requires developers and property owner to locate the critical root zones of roadside trees and demonstrate how these will be protected during construction. County staff determines the feasibility of proposed tree protection plans and if roadside trees are likely to survive construction impacts. If the county determines that trees are not likely to survive construction impacts, then the developer must plant a new tree and pay a $500 fee which the County will use to plant trees in other locations in rights-of-way.

Fairfax County is considered to have one of Virginia's strongest local Tree Conservation Ordinances. Chapter 122 of the Code of Fairfax County Virginia, *Tree Conservation* requires up to 30 percent Tree Canopy Coverage on sites 10-years after land development takes place and can be met through tree preservation, tree planting, or a mixture of both; but tree preservation is emphasized. The ordinance allows for the use of off-site tree canopy banks or contribution to a tree planting fund when any portion of the 10-year tree canopy requirements cannot be met on site. Chapter 12 of the Fairfax County Public Facilities Manual (PFM) contains the technical specifications, design standards, and plan submission requirements for the Tree Conservation Ordinance. The PFM requires the submission of a tree inventory and condition analysis and a tree preservation plan and narrative. The PFM also provides incentives for developers to preserve higher quality trees and endangered or unique forest communities; and, to plant trees for energy conservation in buildings, water and air quality improvements, wildlife benefits, and to use native tree species and improved cultivars. Fairfax County also has a *Heritage, Specimen, Memorial and Street Tree Ordinance* (Chapter 120 of the Code of Fairfax County Virginia) that allows those classes of trees to be designated for protection outside of the context of land development.

- **Community Support:** All three jurisdictions are supported by tree planting and community outreach efforts of non-profit tree organizations. Fairfax County has the support the Support of ***Fairfax ReLeaf, Inc*** which is a non-profit organization formed in 1991 and dedicated to planting trees on public lands. Montgomery County is the home of ***Conservation Montgomery***, a non-profit organization that works to address Montgomery County's environmental and quality of life challenges and provides a forum for county residents who want effective watershed protection and stormwater management, tree-lined streets, a forest canopy providing environmental, economic and aesthetic benefits, workable solutions to the impacts of climate change, and green public space and lush parks. Prince George's County helps community groups plant trees through the ***Tree ReLEAF Grant Program***. This program provides funds for community groups and municipalities to plant native trees and shrubs in public or private common areas.

Table 4. Select Land Use/Land Cover Features of COG's Inner Suburbs

	CBP LULC Class	Acres in 2014	Percent of Inner Suburbs 2014	Acres in 2018	Percent of Inner Suburbs 2018	Gain/Loss
1	Forest	286,992.0	32.56%	276,075.7	31.33%	-1.24%
2	Tree Canopy over Impervious	20,578.1	2.33%	19,291.9	2.19%	-0.15%
3	Tree Canopy over Turf Grass	134,913.5	15.31%	132,838.2	15.07%	-0.24%
4	Tree Canopy, Other	21,177.1	2.40%	21,338.8	2.42%	+0.02%
5	Turf Grass	120,453.2	13.67%	127,811.4	14.50%	+0.83%
6	Natural Succession	20,441.1	2.32%	22,085.3	2.51%	+0.19%
7	Pasture/Hay	52,505.6	5.96%	51,746.5	5.87%	-0.09%
8	Cropland	36,373.6	4.13%	36,054.6	4.09%	-0.04%
9	Harvested Forest	70.1	0.01%	133.2	0.02%	+0.01%
10	Impervious Roads	50,790.0	5.76%	50,939.6	5.78%	+0.02%
11	Impervious Structures (buildings)	43,325.8	4.92%	44,401.6	5.04%	+0.12%
12	Impervious, Other	58,510.3	6.64%	61,801.5	7.01%	+0.37%

Source: 2013/2014 and 2017/2018 CBP LULC tree canopy data published in 2022.

- **Opportunities to Increase Canopy:** A preliminary analysis of 2018 CBP 2022 LULC Project data and zoning designation maps indicates there may be significant opportunities to increase tree canopy in the Inner Suburbs by planting trees:

  - ✓ along streets, in parks and other governmental facilities
  - ✓ on large public, institutional and corporate properties
  - ✓ in lower income neighborhoods to help address environmental equity
  - ✓ on abandoned or underutilized lots and easements
  - ✓ on private property where viable opportunities exist
  - ✓ to reduce Urban Heat Island Effects and the impacts of climate change
  - ✓ to offset fossil fuel energy used to heat and cool buildings
  - ✓ in stormwater management facilities and adjacent to bodies of water to improve water quality and flood control

As in other parts of the COG region, tree planting projects must be methodically planned. The unintended consequences of poor planning can include increased need to prune and remove trees for overhead utility clearance; unnecessary damage to underground utilities and pavements; blocking traffic sight distance, road signage and pedestrian access; increased emissions from fossil fuel-based tree care equipment, etc.

The Inner Suburbs of Northern Virginia have an option of adopting the state enabling authority granted at Code of Virginia §15.2-961.1. (Tree Conservation), which allows localities to place greater emphasis on tree preservation during land development than that granted by tree replacement authority of §15.2-961. The newer Tree Conservation authority of §15.2-961.1. allows Northern Virginian jurisdictions to require higher levels of 10-year (or in some cases, 20-year) tree canopy on land development sites zoned low-density residential (30 percent) and medium density residential (25 percent) than the authority granted by §15.2-961 (Tree Replacement) only allowing jurisdictions to require a maximum of 20 percent 10-year tree canopy. (118)

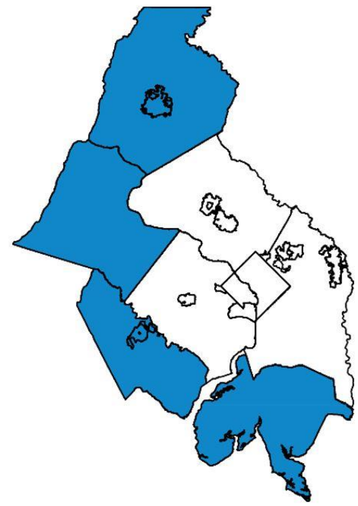
- **Challenges:** CBP 2022 LULC Project data indicates that significant levels of tree canopy were lost to infill development that occurred in the Inner Suburbs from 2014 and 2018. These data indicate that the greatest losses occurred within the Inner Suburbs of Maryland (Montgomery and Prince George's Counties). (1) While the Maryland Forest Conservation Act provides for the conservation of forests and trees on development sites greater than 40,000 square feet in size the law does little to require or encourage tree preservation on smaller sized properties. Notwithstanding the benefits that infill projects can bring to older neighborhood; these benefits can come at price for adjacent property owners when trees located along the periphery of their property are damaged or killed from construction occurring on adjacent properties. This can be especially disruptive in well-established residential neighborhoods that contain mature trees that have root systems that can extend into 3 or more adjacent properties. Unless the tree owners negotiate tree removal costs with the developer of the infill lot, the cost to remove a large tree and stump from the backyard of a small property can easily cost the tree owner $2K to $3k. Tree removal may also affect the aesthetics and resale value of the adjacent property, resulting in increased cooling and heating bills, altering existing drainage patterns, and causing ill-feelings between existing and new property owners. Jurisdictions in the Inner Suburbs are encouraged to determine if their tree regulations can be modified to mitigate the canopy losses and socio-economic impacts associated with infill development.

As in other parts of the COG region, efforts to preserve existing trees should take precedence over tree planting if trees will survive construction in a reasonably healthy and structurally sound manner; however, it should be noted that tree preservation can be considerably more challenging in higher density settings. Decisions to preserve trees in urbanized areas must be based on the realities and limitations imposed by tree biology, and not on public opinion - otherwise the trees retained on development sites may develop into liabilities rather than assets.

COG Outer Suburbs

- The Outer Suburbs include Charles County, Prince William County, Loudoun County, Frederick County plus multiple municipalities embedded within their boundaries. **Geographic and land cover features of the Outer Suburbs**: The combined landmass of the Outer Suburbs is 1,269,402.9 acres. This area represents 57.3 percent of the combined landmass of COG jurisdictions.

- **Tree Canopy Trends:** The average tree canopy coverage in the Outer Suburbs is 51.06 percent. The combined tree canopy area contained in the Outer Suburbs represents 57.3 percent of total COG tree canopy. A significant percentage of this tree canopy is protected by deed restriction and located on protected lands such as flood plains; natural resource protection areas; watershed protection districts; open space; conservation easements and, local, regional, state, and federal parkland. In addition, these jurisdictions currently contain large areas of land zoned for low-density residential use which averages 52 percent tree canopy and has potential to host 55 percent or more tree canopy through tree planting programs on private lots and on common open space. The Outer Suburbs contain a significant amount of active agricultural land located near the suburban-exurban interface. Many of the properties located near this interface appear unmaintained and may have already been purchased for land speculation. The longer these properties remain undeveloped, the higher likelihood they will begin to reforest and contribute to overall canopy gains. The jurisdictions also contain large areas of pastureland that appears to offer potential canopy gains.



- **Major Environmental Services and Benefits:** The 648,138 acres of tree canopy that existed in the Outer Suburbs in 2018 is calculated to have provided the following environmental services and monetary benefits:

	Level of Annual Service	Monetary Equivalent
Air Pollution Removal	46,260,000 pounds	$22,124,000
Stormwater Runoff Reduction	1,844,100,000 gallons	$16,554,600
Carbon Sequestration	816,510 tons	$153,100,000

Services and monetary equivalents are calculated based on 2018 tree cover data using i-Tree Landscape software. It should be noted that tree canopy provides many other environmental, ecological, human health and socioeconomic services, and benefits than those reported above.

A significant number of low-density residential developments located within the outer suburbs are constructed on former agricultural land. The landscapes associated with this land use are largely dominated by turfgrass and appear to offer opportunities to achieve widespread tree canopy gains in the COG region while reducing fossil fuel use, pesticide use, air pollution levels and carbon footprints through public outreach and tree planting programs. The Outer Suburbs also contain large areas of pastureland that appears to offer potential canopy gains.

- **Programs:** In **Prince William County, Virginia**, efforts to preserve and plant trees during land development reviews are evident in various initiatives and policies. One such initiative is the protection of farmland through the purchase of development rights. The county government, through its initiatives, owns the development rights and ensures that even if the farmer decides to sell the land in the future, the buyer does not have the right to build on the land. This initiative, known as the Purchase of Development Rights, allows the county to preserve valuable farmland, forests, and ecologically important resources. This program allows the county government to control the future use of the land, ensuring that it cannot be developed and allowing for tree preservation. Another important program is the Rural Legacy Program, which designates special preservation areas and provides government or private trust funds to conserve farm, forest, and ecologically important resource lands in a contiguous manner. Another notable initiative is the incorporation of low-impact development practices. This approach involves the use of rain gardens, green roofs, retention ponds, porous pavements, and other measures to attenuate and prevent runoff peaks and thereby reduce flood impacts. Furthermore, low-impact development strategies also emphasize the preservation and protection of ecologically sensitive site features such as riparian buffers, wetlands, steep slopes, valuable trees, floodplains, woodlands, and highly permeable soils. This approach ensures that the natural features of a site, including valuable trees, are preserved and integrated into the development plans. The county has implemented various codes and ordinances to ensure the preservation and planting of trees in both public and private spaces.

The Prince William County Zoning Ordinance regulates the preservation and planting of trees during land development processes. Section 32 Article 3 of the Zoning Ordinance, titled "Landscaping, Buffering and Tree Preservation," requires Prince William County developers to submit a landscape and tree preservation plan as part of the site plan review process. This plan must include the preservation of existing trees and the planting of new trees and other vegetation. Furthermore, the Zoning Ordinance stipulates specific requirements for tree preservation and planting. For example, it requires development plans to demonstrate how Tree Canopy Coverage will be met on sites 10-years after land development takes place and can be met through tree preservation, tree planting, or a mixture of both. Additionally, the Zoning Ordinance specifies minimum standards for tree planting, such as the size and type of trees to be planted, spacing requirements, and maintenance provisions. These codes and ordinances aim to protect the existing tree canopy and enhance the overall green infrastructure of the county.

Moreover, Prince William County also has other regulations in place to support tree preservation and planting. The County's Comprehensive Plan includes policies and goals related to tree conservation. These policies outline the importance of maintaining tree cover and encourage the incorporation of trees into development projects to enhance aesthetics, improve air quality, mitigate climate change impacts, and provide various ecological benefits. Furthermore, the Prince William County Tree Preservation and Planting Manual provides additional guidance on best practices for tree preservation and planting. It covers topics such as tree protection during construction, tree planting techniques, species selection, and ongoing maintenance. These codes and ordinances are administered by a County Arborist situated in the Environmental Management Division that directs a staff of arborists that promote tree conservation and enforce tree cover and landscaping requirements and standards.

Local government programs in **Charles County, Maryland** have implemented various initiatives to ensure the conservation of forests and trees during land development. The Charles County Forest

Conservation Ordinance, Chapter 298, is empowered through Maryland State Code Natural Resources Article 5, Subtitle 16, Annotated Code of Maryland. This ordinance aims to conserve forest resources during development activities by identifying existing forest stands, protecting the most desirable forest stands, and locating areas where new forests can be planted. The General Design Requirements of the County's Subdivision Regulations require preservation of priority forests and specimen trees pursuant to the requirements of the Charles County Forest Conservation Ordinance or the Chesapeake Bay critical area requirements of the Zoning Ordinance. The ordinance may also require afforestation where extensive natural tree cover and vegetation do not exist and the planting of street trees along the roadways of properties approved as a part of the subdivision review process. Offsite Forest Conservation Banking is an option for property owners. The sequence for onsite and offsite afforestation, reforestation and retention, and the requirements for establishing a Forest Conservation Bank, are found in Chapter 298, Article IX, of the Code of Charles County, Maryland.

The Charles County Zoning Regulations also require the planting of trees and other plants in peripheral buffer yards to separate properties with dissimilar uses and densities. The Zoning regulations also require planting landscaping and trees along the periphery and in the interior of new parking lots to reduce the visual and environmental impacts of large expanses of parking areas. In addition to programs focused on tree preservation and planting during land development, Charles County established a Transfer of Development Rights program in 1992 that enables rural landowners to sell their development rights to private developers who are then allowed to build at a higher-than-normal density in designated growth areas. Although the focus of the program is to preserve farmland, it often results in the preservation of large, forested tracts as well.

Loudoun County, Virginia: The Loudoun County Urban Forester serves as a resource to the county for forestry or tree-related issues. This position reviews conservation plans and forest management plans, field visits, complaint response, technical assistance, community education and outreach, and mapping and monitoring of forest resources. The Urban Forester also monitors major threats to trees and forests such as insect outbreaks, diseases, severe weather, and wildfires. The Urban Forester is part of the Department of Building and Development's Natural Resources Team.

Loudoun County placed its tree preservation requirements in the Loudoun County Code of Ordinances, Chapter 1245 (Development Standards), Section 1245.14 (Tree Preservation). These requirements apply to subdivision and site plan applications. Loudoun County's Zoning Ordinance contains requirements Tree Planting and Replacement (Section 5-1300), Buffering and Screening (Section 5-1400), and Interior and Peripheral Parking Lot Landscaping Requirements. The technical specifications and plan submission requirements for tree preservation, 10-year tree canopy requirements and other Zoning Ordinance required landscaping are Provided in Section 7.300 of the Loudoun County Facilities Standards Manual.

Loudoun County's Conservation Easement Assistance Program provides financial assistance to landowners in placing their property under a conservation easement. A conservation easement is a voluntary legal agreement in which landowners retain ownership, use, and enjoyment of their property while conveying certain rights to a qualified land trust to protect farms, forested areas, historic sites, and natural resources.

Frederick County, Maryland: The Frederick County Forest Resource Ordinance (FRO) protects and enhances local forest resources. This program was adopted in 1992 to meet the Maryland State

Forest Conservation Act of 1991. This program is administered through the Division of Planning and Permitting and was adopted on December 15, 1992.

On July 21, 2020, the Frederick County Council unanimously voted to reinstate a “no net loss of trees” requirement in the Forest Resource Ordinance (Bill 20-08) - a protection that was previously rolled back in 2011. On August 4, 2020, the Frederick County Council unanimously voted to pass a Zoning Amendment (Bill 20-07) requiring environmental resources to be identified and protected for all future development projects. Forest protection bills 20-07 and 20-08 help ensure that more mature forests and sensitive environmental resources stay intact in Frederick County, and that trees lost to development are responsibly replaced.

- **Community Support: The Charles County Government and the Chesapeake Bay Trust partner to offer funds for forestry projects in Charles County.** The Charles County Forestry Grant Program is designed to increase in the number of acres of forested land in Charles County. Project site proposals are sought from individuals, nonprofit organizations, and contractors. The projects need to agree to preserve and protect the conservation values of the planting project for a minimum of ten years. The goal of this program is to implement cost-effective reforestation projects in the county to increase tree canopy and as a result create forest habitat and improve water quality in the county’s local watersheds and ultimately the Chesapeake Bay.

The Prince William Conservation Alliance seeks to establish desirable, equitable, sustainable communities in both rural and suburban areas and to promote environmental stewardship in Prince William County. This organization promotes community events involving wildlife conservation, watershed protection, and tree plantings.

- **Opportunities to Increase Tree Canopy:** A preliminary analysis of 2018 CBP 2022 LULC Project data and zoning designation maps indicates there may be significant opportunities to increase tree canopy in the Outer Suburbs by planting trees:

  - ✓ along streets, in parks and other governmental facilities
  - ✓ on large public, institutional, and corporate properties
  - ✓ in lower income neighborhoods to help address environmental equity
  - ✓ on abandoned or underutilized lots and easements
  - ✓ on private property where viable opportunities exist
  - ✓ to reduce Urban Heat Island Effects and the impacts of climate change in urban centers
  - ✓ to offset fossil fuel energy used to heat and cool buildings
  - ✓ in stormwater management facilities and adjacent to bodies of water to improve water quality and flood control

The Outer Suburbs of Northern Virginia have the option of adopting the state enabling authority granted at Code of Virginia §15.2-961.1, which allows localities to place a greater emphasis on tree preservation than tree replacement, as permitted by the Tree Replacement enabling authority granted in §15.2-961. This section allows Northern Virginian jurisdictions to require higher levels of 10-year tree canopy on properties zoned low-density residential (30 percent) and properties zoned medium density residential (25 percent) than §15.2-961, which allows jurisdictions to require a maximum of 20 percent 10-year tree canopy. The enabling authority of §15.2-961.1 may prove more valuable to the Virginia Outer Suburbs, which tend to have more properties zoned low and medium residential than those contained in the Core Jurisdictions and Inner Suburbs. (120)

Table 5. Select Land Use/Land Cover Features of COG's Outer Suburbs

	CBP LULC Class	Acres in 2014	Percent of Outer Suburbs Landmass 2014	Acres in 2018	Percent of Outer Suburbs Landmass 2018	Gain/Loss
1	Forest	543,887.73	42.85%	536,200.03	42.24%	-0.61%
2	Tree Canopy over Impervious	8,819.19	0.69%	9,762.25	0.77%	0.07%
3	Tree Canopy over Turf Grass	69,067.99	5.44%	71,368.04	5.62%	0.18%
4	Tree Canopy, Other	30,197.68	2.38%	26,557.12	2.09%	-0.29%
5	Turf Grass	96,379.37	6.87%	101,257.94	7.22%	0.35%
6	Natural Succession	25,592.51	1.82%	25,575.31	1.82%	0.00%
7	Pasture/Hay	224,515.55	16.01%	220,983.05	15.75%	-0.25%
8	Cropland	128,340.02	9.15%	126,222.11	9.00%	-0.15%
9	Harvested Forests	304.25	0.02%	547.06	0.04%	0.02%
10	Impervious Roads	35,282.93	2.52%	36,142.05	2.58%	0.06%
11	Impervious Structures (Buildings)	22,658.79	1.62%	24,778.04	1.77%	0.15%
12	Impervious Other	42,365.72	3.02%	44,578.13	3.18%	0.16%

Source: 2013/2014 and 2017/2018 CBP LULC tree canopy data published in 2022.

Section 3: Possible Canopy Gains and Losses from 2022 to 2050

The tree canopy losses detected between 2014 and 2018 provides an opportunity to project possible levels of canopy between the years 2022 and 2050. Graph 1 plots three possible gain/loss trendlines that could be associated with three different levels of tree conservation. Since the basis for all three of the scenarios are premised on only two data sets separated by 4 years, the accuracy of the projected trendlines is likely to decline significantly five years or more after the date of this report. However, these trendlines are useful for visualizing the relative impacts and costs of different levels of effort by COG jurisdictions. Graph 1 explores the impacts of three different levels of tree preservation, tree planting, and post-planting quality assurance and replacement practices.

An opportunity to project canopy gain/loss trend lines with greater confidence will occur in 2025 and again in 2030 when the Chesapeake Bay Program is scheduled to release land use/land cover data derived from satellite imagery and LiDAR data acquired during 2021-2022 and 2024 and 2025 timeframes. (1) The update will provide an opportunity to utilize three sets of canopy data spread over an eight-year period (2104, 2018, and 2022). As noted previously, the Chesapeake Bay Program is scheduled to acquire and publish new LULC data for the entire Chesapeake Bay Watershed at 5-year intervals.

RTCS used a Tree Canopy Change Projection Model (TCCPM) to project changes to COG's tree canopy coverage over the 29-year life of the regional goal. The TCCOM accepts variable inputs for:

- Canopy gain/loss trends based on CBP LULC tree canopy coverage data
- Canopy expansion curves for different sized plant materials
- Annual mortality and replacement rates
- Remote sensing detection threshold

The TCCPM was used to project three scenarios of canopy gain/loss premised on 2014 to 2018 change detection (loss) in Graph 1 below.

Scenario A projects the loss of 2,483 acres of canopy per year based on the canopy loss detected in the COG region between 2014 to 2018.

- Assumes 2022 canopy level is 49.8 percent.
- Projects 2050 canopy level at 44.4 percent (decrease of 5.4 percentage points or a 10.8 percent loss).
- Based on current level of canopy loss and the effectiveness of current tree conservation efforts throughout the COG region.

Scenario B projects possible canopy gain/loss between 2022 and 2050 based on the following parameters and assumptions:

- Assumes 2022 canopy level is at 49.8 percent.
- Projects 2050 canopy level at 46.3 percent (decrease of 3.5 percentage points or a 7.0 percent loss).
- An average of 109,300 trees planted each year within the entire GOG region.
- Plant material are all containerized or balled and burlapped nursery stock trees.
- Minimum planting size of trees is 2-inch caliper.
- Trees are planted on both private and public property with 45 percent placement on low and medium density residential properties.

- Annual mortality rate set at 15 percent (20 percent initial mortality offset by 5 percent replacement).
- Canopy expansion of individual trees is based on average horizontal canopy growth of 24 shade tree species starting with the first year the tree is planted and culminating at 1087 square feet after 29 years of growth.
- Remote sensing detection threshold of individual canopies starts at year 9 year after initial planting dates and based on the assumption that 1-meter resolution imagery supplemented with LiDAR data can be used to consistently detect a 10.5-foot diameter crown spread belonging to an individual tree.
- Tree preservation efforts associated with land development are increased by 5 percent.

Scenario C projects possible canopy gain/loss between 2022 and 2050 based on the following parameters and assumptions:

- Assumes 2022 canopy level is at 49.8 percent.
- Projects 2050 canopy level at 48.1 percent (decrease of 1.7 percentage points or a 3.4 percent loss).
- An average of 206,000 trees are planted each year within the entire GOG region.
- Plant material is all containerized or balled and burlapped nursery stock trees.
- Minimum planting size of trees is 2-inch caliper.
- Trees are planted on both private and public property with 45 percent placement on low and medium density residential properties.
- Annual mortality rate set at 15 percent (20 percent initial mortality offset by 5 percent replacement).
- Canopy expansion of individual trees based on average canopy spread of 24 tree species of 1087 square feet after 29 years of growth.
- Remote sensing detection threshold of individual canopies starts at year 9 year after initial planting dates and based on the assumption that 1-meter resolution imagery supplemented with LiDAR data can be used to consistently detect a 10.5-foot diameter crown spread belonging to an individual tree.
- Tree preservation efforts associated with land development are increased by 10 percent.

Graph 1: Projected Changes to COG Region Tree Canopy 2022 to 2050

The vertical axis represents the percentage of combined COG landmass covered by tree canopy.
The horizontal axis represents years covered by the region goal beginning with 2022 and ending in 2050.

Table 6. Acres of Tree Canopy Loss associated with Scenarios presented in Graph 1

Scenario	2022 Tree Canopy Coverage	2050 Tree Canopy Coverage	Offset by Tree Planting 2022 to 2050	Offset by Tree Preservation 2022 to 2050	Total Tree Canopy Loss 2022 to 2050
A	49.8 %	44.4%	N/A	N/A	119,932.4 acres
B	49.8 %	46.3%	39,019.2 acres	4,173.6 acres	76,739.6 acres
C	49.8 %	48.1%	74,136.5 acres	8,788.6 acres	37,007.4 acres

Costs and Benefits of Tree Planting and Tree Preservation

The costs and benefits presented in this section are used to demonstrate the financial and environmental impacts associated with the two primary methods of tree conservation: 1) planting trees (reforestation), and 2) retaining existing trees. The information includes the relative costs per acre and return on investment associated with tree planting, and the ecosystem services and associated monetary benefits provided by existing trees and forests annually, and the level of three important environmental services and associated monetary benefits that will be lost if the 2014 to 2018 canopy loss trend line proves accurate.

Costs and Benefits of Tree Planting

The actual costs associated with tree planting are likely to vary significantly based on the mixture of reforestation methods (e.g., nursery stock trees, seedlings, whips, native seed mixes) and the reforestation/landscaping objectives that jurisdictions decide are appropriate to address specific site conditions and uses. Canopy gains and costs based on planting forty (40) 2-inch caliper nursery stock trees per acre are presented as a relatively simple way to provide an acre of upper canopy that will coalesce and become detectable as canopy via remote sensing technology within a relatively short period of time. This method of tree planting is often used on residential, commercial, industrial properties and in parks, rights of ways, and common open space; however, it is not a cost-effective method for restoring forests which have multi-layers comprised of upper story, mid-story and understory plants, and have an inherent capacity to replenish trees through seeding, and to facilitate the growth of woody shrubs, forbs and/or grasses in the lower canopy layers.

Planting nursery stock trees. Offsetting the annual rate of canopy loss detected between 2014 and 2018 (Scenario A) would require reforesting approximately 4,300 acres of canopy within the COG region each year. If planting 2-inch caliper nursery stock trees were the only reforestation method available to offset this magnitude of loss it would require planting approximately 7.2 million trees over 29-year period, or an average of 247,000 trees each year at a cost of $123.5 million. This number of trees is based on planting 40 shade trees per acre with a 15 percent mortality rate during the first 5 years. 40 trees per acre is based on the average canopy expansion of 27 frequently planted trees and the number of trees it would take to provide one acre of canopy coverage in 29 years. [(119)(120)] It is anticipated that the nursery industry would have significant difficulty meeting this level of tree demand, consequently this scenario is solely offered to demonstrate the cost of using 2-inch caliper nursery stock trees to offset 119,932 acres of tree cover loss associated with Scenario A.

The Scenario B illustrates the impact of offsetting 41,623 acres of canopy loss over a 29-year period and is projected to result in a 46.3 percent canopy coverage by 2050. This scenario represents a combination of planting 2-inch nursery stock trees and the result of increasing the area of tree canopy preserved each year during land development by 5 percent which represents a modest increase. The tree planting required in this scenario is estimated to require 3.17 million trees over the entire 29-year period of the proposed regional canopy goal.

As stated previously planting nursery stock trees is not likely to be the only method used to offset canopy losses. Depending on the planting site being targeted, reforestation by smaller caliper nursery-grown trees (e.g., 1.5-inch to 1-inch caliper stock), tree seedlings and saplings, establishment of "no-mow" zones, and reforestation through natural succession could substantially reduce the cost, labor and logistics associated with planting larger caliper trees. One 2-inch caliper tree costs approximately $500 per tree, or $20,000 per acre to plant based on retail cost to purchase and plant one 2-inch caliper tree by a landscape contractor that offers a 1-year conditional replacement guarantee. Planting a slightly smaller 1.5-inch caliper tree of the same species costs less than a 2-inch caliper tree (approximately $375 versus $500 per tree [121] or $15,750/acre versus $20,000/acre). Planting 1 to 1.5-inch caliper trees is likely to result in a similar amount of tree canopy as a 2-inch caliper tree over a ten-year period and are typically easier for homeowners to transport in family vehicles because of their smaller height (6 to 10 feet) and smaller root container (10 gallon versus 20 gallon). [122]

Planting with Saplings. Saplings (a.k.a. "whip") is a general term that describes the stage of tree growth that follows the seedling stage. Saplings are young trees less than 2 years old. Sapling plantings work well in large restoration projects, but they are not the best method to establish tree canopy in managed private or commercial landscapes unless they can be closely monitored and maintained. Their smaller size makes them more venerable to damage from various sources including human traffic, deer browse, insect damage and harsh weather. Individual saplings costs can cost $35 to $140 [123] to plant depending on size and may require anywhere from 150 to 600 saplings per acre to establish the equivalent area of tree canopy established via nursery stock trees. The cost to plant an acre of saplings by a professional contractor varies from $6,000 to $14,000 depending on the species used, site conditions and amount of site preparation that is needed. However, it is important to note that saplings are often planted by non-profit tree planting groups because of the low cost per tree and the fact that volunteers can be used to plant this size tree with reasonable survival rates.

Planting with Seedlings. A tree seedling is a young tree grown from seed and generally less than three feet in height. Tree seedling costs may range from 25 to 45 cents per seedling or from $100 to $200 per acre to plant. Site preparation and follow-up maintenance can increase the costs to $600 per acre. [124] This magnitude of cost-saving appears promising; however, the use of tree seedlings, and no-mow zones is limited to more rural and/or less formal landscapes. Consequently, these alternative methods are more limited in application than nursery stock trees. The USDA Forest Service describes one method to create forested conditions as planting approximately 170 seedlings per acre while allowing some shrubs, forbs, and grass grow to develop between seedlings. This

A study conducted by the US Forest Service estimates that $3.74 is returned on every dollar invested in the planting and care of trees typically planted in our region.

approach is called “applied nucleation” and assumes 25 percent natural mortality and results in 130 trees per acre surviving at age five. [125] This method results in a more diverse plant community that the “plantation” approach which is typically used to establish timber harvest stands and typically requires 400 to 700 seedlings per acre depending on the tree species planted and wood product objectives. Although tree seedling and saplings are planted at much smaller sizes than nursery stock-sized trees, those that survive often catch up in height and crown spread to nursery stock trees of the same species within 10 to 15 years after both are planted. However, they experience much higher mortality rates than nursery stock trees because their smaller physical size makes them more vulnerable to extremes in weather, wind desiccation, pest damage, animal browse and vandalism. Higher mortality rates are normally accounted for by planting more seedlings within the same area. If planted correctly, seedling and saplings generally avoid developing many of the structure problems often associated with nursery-grown trees such as root girdling and splitting codominant trunks. Seedling and saplings typically have a smaller environment footprint at time of planting than their nursery grown counterparts because they weigh less and typically spend less time in transport which translates into lower greenhouse gas emissions per tree planted.

Planting Costs Associated with Scenario B. Planting nursery stock trees of various caliper sizes in suburban and urban landscapes offers communities the ability to strategically locate tree canopy to deliver specific socioeconomic, environmental, and human health services. However, efforts to offset tree canopy losses through tree planting is likely to involve a mixture of reforestation modes that include nursery stock trees of different caliper sizes, saplings, and seedlings. One possible mixture of reforestation practices applied to Scenario B could involve 20 percent 2-inch nursery stock trees, 35 percent 1.5-inch nursery stock trees, 15 percent saplings, 25 percent seedlings, and 5 percent no-mow/natural succession. This mixture is estimated to cost approximately $15.2 Million a year to implement with a total cost of $440 million over a 29-year period. Both the yearly and 29-year cost could be significantly reduced if large number of trees end up being planted by homeowners and/or non-profit tree planting groups.

Services and Benefits of Planted Trees. Tree planting often provides cost-effective solutions to many of the challenges faced by local governments. Studies conducted by the USDA Forest Service indicate that the monetary benefits associated with potential tree services and benefits outweigh the costs incurred while planting and maintaining the same trees, plus costs associated with mitigating negative tree impacts. The study approximates that the average net benefits of a medium sized yard tree equate to $960 over a 40-year period, while the net benefits of a large yard tree located on the western side of homes equates to $3,680 over the same period. The study also estimates that the monetary equivalents of the environmental services provided by trees (e.g., energy savings, stormwater- runoff reduction, improved air quality, and reduced atmospheric carbon dioxide), add up to more than three times greater than the cost associated with ongoing tree maintenance. [105] Additional information concerning the services and benefits of urban trees can be found in Sections 1 through 8 of Part 1 of this report.

Ensuring Genetic Diversity in Planted Tree Populations is Critical. Higher levels of genetic diversity within a tree population results in a healthier and more sustainable tree canopy. Past overplanting of a single species and/or genus has resulted in a newly introduced disease or pest being able to decimate a large percentage of a community’s trees. A classic example of this is when American Elm was overused as a street tree in the late 19 and early 20 century and was quickly decimated when in 1928, a shipment of elm logs came from Europe introduced a new pathogen (a fungus, *Ophiostoma ulmi*) to North America. The disease took the name of the first species it victimized—Dutch elm disease. The American elm had no long-term history with the fungus and therefore no resistance, and rapidly succumb when exposed. [126] A more recent example of an introduced organism that is decimating an entire family (genus) of trees is the Emerald Ash Bore (*Agrilus planipennis*) that is responsible for the destruction of tens of millions of ash trees in 30 states. Native to Asia, it likely arrived in the United States hidden in wood packing materials. [127]

Trees that are a part of natural forest communities reproduce via pollination, seed production and natural methods of seed dispersal. These processes result in higher levels of genetic diversity than are associated with nursery-grown trees which are often reproduced via tissue cloning, grafting, and other methods that use identical or similar genetic materials repeatedly in their method of propagation. These methods are designed to consistently produce trees with identical physical characteristics, so they are more marketable, or are bred to be less susceptible to known pests or diseases and/or specific environmental stresses. Tree cultivars/varieties produced by these methods can be used to address specific environmental and aesthetical concerns; however, their overuse, especially in monoculture groupings can undercut the overall genetic diversity of a community's tree population and subject it to higher mortality rates. Even at neighborhood scales, community tree populations should be comprised of a wide variety of species to minimize the impacts of new diseases or pests that are resistant to treatment. There is growing consensus that species diversity in plant populations (and otherwise) promotes a wider array of ecosystem functions and services. [128] [129] [130] [131]

Use of Native Trees Versus Tree Cultivars. The use of native trees is often emphasized or even required in local tree regulations. This is generally a sound concept because it limits the use of potential invasive tree species, it is important to note that nominally native tree cultivars produced using tissue cloning, grafting, or other methods of vegetation propagation that repeatedly utilizes identical genetic material can limit species diversity if not used sparingly. Although these cultivars may be labelled as 'native" because they were developed from a species native to North America, their use in monoculture planting schemes can erode genetic diversity.

Regulating Species Diversity. To help ensure species diversity at local levels, jurisdictions should consider regulating species composition when developers are required to meet tree and landscape ordinance requirements through onsite tree planting. One example of this type of provision can be found in Chapter 12 of the Fairfax County Public Facilities Manual, which in part regulates tree planting used to meet 10-year tree canopy requirements. These provisions read "If 30 or more trees are required to be planted on a site, then no more than 10 percent of the total number of trees should be composed of one species and no more than 33 percent of the total number of trees should be composed of one genus." [132] It is important to note that nursery-grown trees, seedlings, and saplings that are grown from seed can generally be regarded as supporting genetic diversity as long as the species is not over utilized.

The Costs and Benefits of Tree Preservation.

Preserving existing trees offers many advantages over planting new trees. First, as stated previously in this report, mature trees offer immediate services whereas planted trees can take 30 years to more to offer the same level of services. Research by the USDA Forest Service demonstrates that large trees greater than 30-inches in diameter can remove as much as 60 to 70 times more air pollution annually than small healthy trees. [103] It stands to reason that mature trees also provide higher levels of stormwater mitigation, carbon sequestration, energy conservation, etc., due to possessing much greater biomass and leaf surface area than newly planted trees.

Part 1 of this report entitled "***The Case for Conserving Trees and Forests in the Metropolitan Washington Region***" contains a comprehensive review of the benefits and services provided by trees and forests including the impacts of existing canopy on human health and quality of life, environmental equity, neighborhood cohesiveness and crime reduction, local retail business and economies and resilience to climate change. The information below provides an overview just a few of the more immediate benefits provided by preserving trees on new neighborhoods.

Wildlife Benefits. Preserving existing trees provides the immediate benefit of preserving existing wildlife habitat, food and migration stopovers for numerous mammals, birds, insects, and other organisms. Can planted tree canopy provide significant levels of wildlife benefits? Yes, urban trees, including yard and street trees can provide many of the same wildlife services as native forest communities, although again, planted trees take many years to provide these services and the types of wildlife they attract and benefit are somewhat different, primarily because planted tree canopy lack of larger corridors that larger wildlife species seem to prefer. (133)

Preserving Trees can Considerably Boost the Market Value of New Homes. Research conducted in 2010 by the USDA Forest Service in Portland Oregon found that, on average, street trees added $8,870 to a house's sale price and decreased the house's time on the market by 1.7 days. The study also found that a single tree raised the value of multiple houses. A tree with an average canopy of 312 square feet added an average $7,130 in value to the house it fronted, plus additional value to neighboring houses.

The study also found that only about one-third of the total benefit goes to the property where the tree is located. The rest of the benefits are spread out to neighboring properties within 100 feet, and in the neighborhoods studied, added an average combined value of $12,828 to the houses (typically 7 to 8) located within that radius. (134)

Air Quality, Stormwater Reduction and Carbon Sequestration Services. Based on 2014 to 2018 canopy loss trends, increasing the area of tree canopy that is preserved in connection with land development each year in the COG region by just 10 percent is estimated to provide the following levels of environmental services and equivalent monetary benefits that would otherwise be lost, both on an annual basis and over a 29-year period.

Table 7. Environmental Services and Benefits Associated with a 10% loss of Existing Canopy

	Annual Air Pollution Removal in LBS	Gallons of Stormwater Runoff Reduced Annually	Tons of Carbon Sequestered Annually
Service	7,983,710/year	616,171,576/year	141,842 tons/year
Monetary Benefit	$9,643,014/year	$5,579,099/year	$26,569,310 tons/year
Accumulated Service over 29-years	231,527,592 lbs.	17,868,975,699 gallons	3,546,051 tons
Monetary Benefit over 29-years	$279,647,415	$161,793,881	$770,510,000

Source: Understanding Your Canopy. Chesapeake Tree Canopy Network. Services and monetary benefits extrapolated from 2018 tree cover data using iTree Landscape software. https://chesapeaketrees.net/understand-your-canopy/

James Wheeler/pixabay

Dafacct/pixabay

The services and benefits provided by trees grown in forested conditions and trees planted in suburban and urban environments overlap but often differ in the magnitude of the service and benefit provided. This is because the site conditions and features that each group interacts with differ significantly. For example, both forest trees and urban trees provide stormwater mitigation services, but trees growing in forested conditions typically provide much higher levels of stormwater reduction than urban because they are growing in uncompacted and living soils that act as a huge sponge in soaking up and detaining rain. Another difference lies in their Heat Island reduction services. Although forested areas can indirectly influence Heat Island effects in urban centers through evapotranspiration and subsequent cooling of ambient air temperatures surrounding cities, the crowns of urban trees are situated directly between buildings and over pavement areas that collect and store heat, so they are simply situated better than forested trees to provide this service.

In general, forests tend to provide much greater levels of environmental and ecological services (e.g., air and water quality improvements, and wildlife habitat) than urban trees. On the other hand, urban trees tend to provide higher levels of socio-economic services (e.g., increased foot traffic in urban retail centers, and increased market value of new homes) than forest trees.

It is important to note that urban tree canopy that is comprised of individual trees is “easier” to establish than forest ecosystems which consist of plant, insect and animal species tied together by physical and biotic processes governed by unique geological, topographical, and climatic conditions. Once the successional sequence, structure, interactions, and conditions that define forest ecosystems are destroyed, it can be very difficult if not impossible to reproduce. (135) These differences should be kept in mind when setting community tree canopy goals and prioritizing tree conservation objectives.

Once the successional sequence, structure, interactions, and conditions that define forest ecosystems are destroyed, it can be very difficult if not impossible to reproduce. (135)

Section 4: Intermediate Target Goals based on Population Density and Urbanization

Intermediate target goals provided in Table 8 are intended to help COG communities set and monitor tree canopy goals for intermediate sized areas such as political sub-boundaries, watersheds, planning districts, census tracts, or even entire jurisdictions within the COG region. The recommended range of tree canopy listed in the far-right column is closely tied to the actual canopy levels associated with different densities of human population and degrees of urbanization detected in CBP 2022 LULC Project data. The population densities were derived from 2018 Federal Census Data. Unlike the smaller scale target goals recommended in Section 5, these goals are not based on mature canopy levels 40-plus years after land development has taken place but reflect the entire range of tree age and overall level of canopy coverage one might find at any given time within the area of interest.

The lower percentage in the target range indicates the minimal level of tree canopy that is recommended in order to support the Regional Tree Canopy Goal. The higher end of the target range is premised on the level of canopy that RTCS determined optimal given the types of physical constraints observed within each level of population density and degree of urbanization listed; plus, the number of tree planting opportunities that were detected in those categories. The Broad Land Use Descriptions are used to organize population densities into recognizable categories of land use. The Canopy Target Goal Ranges in the right column in Table 8 represent best management practices and general guidance. They are not intended to be used in a prescriptive manner or to be interpreted as universally applicable to all settings.

Table 8. Recommended Tree Canopy Goals based on Population Density

Density of Human Population per: • 1 square kilometer • 0.4 sq. miles • 260 acres	Broad Land Use Description	Percentage of Tree Canopy detected in 2018	Recommended Range of Tree Canopy to Target
Urban Centers			
>3,000	Densely Urbanized	33.5%	35 - 40%
>1,500 to 2,999	Urbanized	39.2%	40 - 45%
< 1,500	Suburban/Residential	38.5%	45 -55%
Areas in COUNTIES			
>2,000	Densely Urbanized	40.2%	35-45%
1,000 to 2,000	Urbanized	56.7%	55-60%
700 to 999	Partly Urbanized	56.3%	55-60%
300 to 699	Suburban/Residential	50.4%	55-60%
<299	Exurban areas transitioning from former agricultural uses	54.9%	50-55%
<299	Exurban areas w/active agriculture	44.8%	40 - 45%

Section 5: Smaller Scale Target Goals Recommended for Land Use Categories

This section identifies the average level of tree canopy coverage associated with 18 general classes of land use categories located within the COG region in 2017 to 2018, along with small scale target goals that COG jurisdictions should find achievable 40 years or more after initial land development has taken place. Both sets of information are presented in Table 9, on page 68.

2018 Canopy Levels and Land Use

In 2019, the Climate, Energy, and Environment Policy Committee (CEEPC) charged the Regional Tree Canopy Subcommittee (RTCS)with recommending tree canopy target levels for major land uses. To produce these recommendations, RTCS researched land use definitions from multiple COG communities. It became quickly apparent that COG communities organize and label their land use categories and associated densities quite differently. Consequently, RTCS requested help from COG land use planners who recommended a set of generalized land use categories that RTCS would be able to align with the proprietary definitions adopted by COG member jurisdictions. After analyzing the applicability of nine generalized land use categories, RTCS generated an additional nine categories to ensure that the final set of target goals addressed a more comprehensive and nuanced range of land uses.

Methodologies Used to Identify 2018 Tree Canopy Coverage

In 2021, RTCS set out to classify land use and zoning data from COG communities into the 18 land use categories identified in Table 9. Once this was done, RTCS used CBP 2022 LULC Project data (based on imagery acquired during 2017 and 2018) to calculate the proportion of each land use type that was covered in tree canopy. One-meter resolution can detect individual trees, which make up a large part of the urban tree canopy. LiDAR datasets were used to increase the accuracy of the land cover data which delineates tree canopy boundaries. Once the analysis of 2018 canopy data was complete, RTCS deliberated and refined canopy target goals for all 18-land use categories which range from those that must restrict tree growth (e.g., airports, quarries) to those that provide more open space (e.g., parks, arboreta). The range of tree canopy target goals spans 10 to 80 percent.

Intended Application of Small-Scale Land Use Canopy Target Goals

The percentages of tree canopy identified in the Target Goal column of Table 9 are offered solely as general guidance for use during land use planning exercises and are not intended to be used in a prescriptive fashion or construed as universally applicable to all scenarios. Tree conservation objectives, including canopy levels, associated with individual neighborhoods and parcels must be determined on a site-by-site basis and refined by community values and local land use policies. However, the target goal percentages provide only a general indication of the level of tree canopy that is possible once existing and new landscape features have adapted to newly built environments. The composition of the canopies on these properties varies based on the use and may reflect a mixture of naturally seeded and planted trees.

The COG Regional Tree Canopy Subcommittee discussed categories of land use, and what guidelines should be provided as recommendations for tree canopy targets on these land uses. Because of the wide range of zoning codes and land use categories used by the communities in the membership of COG, land use categories were selected and described, instead of quantified by specific development densities. This approach allows for wider application across the region. RTCS is optimistic that COG communities will find the target goals to be realistic and achievable. We have analyzed and discussed the relationship between tree canopy and land use over the past three years to identify goals that straddle the line between aspiration and pragmatism while balancing a wide range of social, economic, environmental, and ecological interests. Each community is encouraged to look at the target goals provided on Table 9 and compare these with canopy levels present in their own communities and use the smaller scale targets goals to help shape their planning policies and documents. RTCS strove to recommend realistic target goals, but always encourages communities to customize these recommendations if needed to address local conditions.

Source: Google Maps

Table 9. Smaller Scale Tree Canopy Target Goal Levels Recommended for Land Uses

	Land Use *Type/Density*	Examples and Considerations	2018 Canopy Levels	Target Goal
1	Residential, Low	Detached homes, either single-family or duplex. Primary land use type hosting tree canopy	52%	55%
2	Residential, Medium	Single Family homes with medium yards. Attached homes, such as townhomes or single/double story multi-family buildings	47%	50%
3	Residential, High	Single family homes with narrow setbacks, townhomes, high-rise condominiums & apartment buildings with parking lots and limited open space	36%	35%
4	Residential, Urban High	High rise condo buildings & apartment buildings only	No Data	25%
5	Commercial, Low	Single or double-story buildings, sometimes with parking lots, e.g., office parks	23%	35%
6	Commercial, Medium	Multi-story buildings, with parking lots and/or small parking garages	23%	30%
7	Commercial, High	High rise commercial	23%	25%
8	Mixed Use (Medium)	Commercial mixed with residential or other compatible uses, including high density mixed use. Varied definitions across COG jurisdictions	38%	40%
9	Mixed Use, High	RTCS added this category to differentiate from the conventional Mixed-Use category	38%	25%
10	Industrial and Railway	Manufacturing, Industrial parks, quarries/asphalt /concrete plants, railways, and their immediate rights-of-way	32%	30%
11	Park, Low Development	Natural parks with trails, and minimal constructed facilities (nature centers, bathrooms) and arboreta	No Data	80%
12	Park, Medium Development	Passive recreation (cemeteries, gardens, and golf courses)	No Data	40%
13	Park, High Development	Sports fields, paved plazas, heavy traffic urban parks with high density of buildings	No Data	30%
14	Local Roads	Leading to residential or connecting small residential roads, low speed	No Data	20%
15	Arterials	Transportation within a local community, medium speed	No Data	15%
16	Freeways and Highways	Interstate Transportation, high speed	No Data	15%

17	Airports, Quarries, Landfills & Uses Restricting Tree Growth	Often have space to plant buffers and in areas dedicated to arrivals/departures, parking lot landscaping and pedestrian areas	No Data	10%
18	Agricultural	Consider stream buffers and road buffers, not including commercial forests and nurseries	No Data	25%

Note for "No Data" = there is high variability of land cover for this land use type.

Section 6: Metrics of Success

"Tree canopy coverage" is a conventional concept used to communicate the level of trees and forests that exist within a given geographic area, and to a lesser extent, to imply the relative success of tree conservation efforts within that area. Although broadly used, tree canopy coverage should not be regarded as the penultimate measure of success or failure of tree conservation. The metric is two-dimensional and does not directly measure other important facets of trees and forests such as their long-term health and sustainability, or their capacity to impact our daily lives or the quality of the environment in which we live and work.

For these reasons RTCS recommends implementing additional methods that can be used to measure and monitor the quality of tree canopy and gauge how it interacts with human beings and our environment. This report provides an overview of methods that could be used to:

- Measure the biodiversity, resilience, and sustainability of tree canopy.
- Measure how tree canopy impacts quality of life, human health, and environmental equity.
- Measure how tree canopy impacts our environment and natural resources.

It is important to note that several of the methodologies and indexes identified below are already widely practiced while others have been recently introduced. All are offered to stimulate interest, additional research and discussion within COG communities. Many of the metrics presented in this section are discussed in more depth in Sections 1 and 2 of Part 1.

Measuring the Biodiversity, Resilience, and Sustainability of Tree Canopy

- Biodiversity: Tree populations require genetic variation to develop resistance to acute and chronic stressors, such as pests and diseases, and the impacts of climate change. Biodiversity's value applies to naturally occurring trees and nursery grown varieties and cultivars. Methods used to benchmark and monitor biodiversity in tree populations include tree inventories and remote classification using hyperspectral imagery.

- Tree Inventories: A tree inventory is a record of location and characteristics of individual trees, including their species, which is used to identify the diversity of tree species represented in an entire area of tree canopy or an entire jurisdiction.

- Partial Inventory: Conducted on a specific non-random area. It may be a geographic area, such as a downtown. It may be a phased inventory where different areas are collected at different times, with the goal of each phase eventually comprising a complete inventory.

- Complete Tree Inventory: Primarily used by small communities and conducted over a complete geographic area. When used to collect information about public trees may only cover areas maintained by the local government.

- Sample: (Stratified Random Ground Truthing) A sample inventory is conducted on a random sample of street segments, blocks, road miles, or area to provide an estimate for the urban forest. Typically, the sample is 3 - 10 percent. The sample can also be stratified.

- Health: Measuring and monitoring the health of trees through complete or partial surveys, or through stratified random sampling is critical to urban forest management and planning.

- Forest Inventory and Analysis(FIA): FIA reports on status and trends in a forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates for various products; and in forest land ownership and management.

- Urban Forest Inventory & Analysis: The FIA program has established itself as the only comprehensive field-based and annually updated inventory of all forest ownerships for each of the 50 states in terms of measuring "forest land." In order to prevent areas of tree canopy that do not meet this definition from falling through the gaps, the FIA program has collaborated with the USDA Forest Service to fuse the infrastructure of the FIA program with the urban inventory function of the i-Tree program to form the new Urban FIA protocols which will be used to produce design-based estimates of the quantity, health, composition, and benefits of urban tree canopy and native forests. Information about iTree can be found at: https://www.itreetools.org/tools

- Structural Diversity and Age: In native forest communities, distribution of structure and age within tree and understory populations help to ensure stability of the forest community over time. In these communities a high proportion of seedlings and saplings are continuously introduced into larger diameter classes. Annual germination of seedlings offsets mortality from abiotic and biotic factors, however, the continuous aspect of this natural process may be lost if communities fail to regularly provide sufficient resources to restock urban tree populations. Irregular restocking can result in large areas of mature trees needing removal within relatively short time periods without the prospect of timely tree replacement. To address this issue, restocking should automatically be built into tree and stump removal programs.

A wide range of diameter and age classes is usually necessary to ensure long-term sustainability of both urban tree populations and native forest communities. Monitoring structural diversity and age distribution in native forest communities may be needed to manage high rates of seedling suppression and mortality associated with unmanaged populations of herbivores (e.g., white-tailed deer, rabbits) [136] and invasive plants (e.g., Wavyleaf basketgrass, Japanese angelica tree). [137] Structural diversity of tree populations can be analyzed by measuring and compiling tree diameter through various inventory methods. Diameter class distribution can act as a proxy for age distribution in urban tree population if planting date records are not available.

Measure How Tree Canopy Impacts Quality of Life, Human Health, and Environmental Equity

- Quantifying human health benefits and measuring environmental equity that is associated with urban greenspaces (includes trees and forested areas): Several organizations have developed methods to forecast human health outcomes at specific locations and to gauge levels of environmental equity present within entire communities and individual neighborhoods. These include:
    - **NatureScore.** ™ This score measures the amount and quality of natural elements of any address to predict the protective impact nearby nature may have on human health and longevity relative to a base of a nature deficient area. For more information, visit NatureScore.
    - **Nature Priority Index.** Use of this index allows researchers, non-profits, municipalities, ESG investors, and others to be able to quickly identify communities that are both nature-deprived and have socioeconomic disadvantages (low income, low education, low employment, poor housing, etc.). This index can be used to prioritize the delivery of green infrastructure and help inform public health delivery and policy, especially for the most disadvantaged neighborhood groups. For more information, visit Nature Priority Index.
    - **Tree Equity Score.** This score calculates scores based on how much tree canopy and surface temperature align with income, employment, race, age, and health factors. In the U.S. scores are available for 150,000 neighborhoods and 486 urbanized areas. Each score indicates whether there are enough trees in specific neighborhoods or municipalities for everyone to experience the health, economic, and climate benefits that trees provide. For more information, visit Tree Equity Score.
    - **ParkScore.** This score was developed by the Trust for Public Land to measure how well the 100 most-populous U.S. cities are meeting the need for parks and greenspace. It is used to assign points for 14 measures across five categories: acreage, investment, amenities, access, and equity. For more information, visit ParkScore.

Measuring How Tree Canopy Is Impacting our Environment and Natural Resources

- By understanding the services that trees provide COG communities can link tree canopy goals with air and water quality, climate change mitigation, and community livability. Communities now have multiple tools to quantify these services which include:
    - Carbon storage
    - Carbon sequestration
    - Reduction of Heat Island effects
    - Air quality improvement
    - Water quality improvement
    - Reduction of energy used to heat and cool buildings
- **iTree Software Suite**: i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools.

The i-Tree tools can help strengthen forest management and advocacy efforts by quantifying forest structure and the environmental benefits that trees provide. Although the iTree Software suite does not currently incorporate scores or metrics per se, it does quantify levels of tree services which have potential to feed metrics and other tree canopy specific goals. The following list identifies several iTree modules that could be used to support tree canopy metrics and goals.

- **Tree planting tools** - Specific tools to help with your tree planting projects:
  - iTree Planting – Used to forecast mass planting benefits and services.
  - iTree Species – Used to place the "right tree in the right place."
  - iTree TrillionTrees - A collective mapping site for MyTree; track your community planting efforts through your web browser.

- **iTree Landscape** – This module can be used to identify priority planting & protection areas for climate and social justice. Many community-specific map layers and data tables are provided all in one place.

- **iTree Eco** - This is the flagship iTree module tool that is used to quantify tree services and monetary benefits associated with an existing tree inventory or the tree canopy of an entire jurisdiction.

Valentin/Pixabay

PART 3: IDENTIFYING THE RIGHT LEVEL OF TREE CANOPY FOR YOUR COMMUNITY

An Urban Tree Canopy (UTC) assessment quantifies a community's tree canopy coverage. Understanding the extent of a community's forest and tree resources is a critical step in identifying how to manage these resources. UTC assessments are often used to establish and implement community tree canopy goals that contribute to a broader set of environmental and sustainability initiatives and enable communities to generate management plans and to make policy decisions. These assessments are most useful when combined with other information—such as the extent and locations of impervious surfaces and buildings, waterways, socioeconomic and health data, and heat island maps.

The 10-steps presented in this report provide processes and tools that COG jurisdictions can use to identify achievable canopy goals that balance a wide range of socioeconomic, environmental, and ecological concerns. The sequence generally follows the steps and processes provided in the USDA Forest Service publication entitled "Urban Tree Canopy Assessment: A Community's Path to Understanding and Managing the Urban Forest" which can be viewed and downloaded at: https://www.fs.usda.gov/research/treesearch/59006

Another useful guide to setting canopy goals prepared by the USDA Forest Service is the *The Sustainable Urban Forest, A Step-by-Step Approach. Davey Institute / USDA Forest Service.*

This publication digs deeper into local land use planning processes than the Forest Service UTC assessment and follows this 10-step process:

1. Identify Tree Canopy Baseline
2. Identify Tree Canopy gain/Loss Trends
3. Estimate the Level of Services and Benefits Provided by Your Trees and Forests
4. Identify Areas of Existing Tree Canopy That Are Currently Protected
5. Forecasting Post-Development Canopy Levels
6. Identify Potential Areas to Plant Trees
7. Identify a Potential Canopy Goal
8. Integrating Tree Canopy Goals
9. Gaining Local Government Support of the Tree Canopy Goal:
10. Public Engagement – Creating a Sense of Ownership in the Community

STEP 1: Identify Tree Canopy Baseline:

The initial step in identifying any tree canopy goal is to identify a baseline of canopy coverage. This typically involves using recent leaf-on imagery (i.e., digitized aerial photography or high-resolution satellite imagery), LIDAR, elevation, and building footprint data to produce land cover maps to delineate impervious structures, bodies of water, barren land, emergent wetlands, shrubs, low growing herbaceous vegetation, and tree canopy. Having the ability to view additional land cover features juxtaposed with tree canopy helps planners best understand how trees are integrated into the overall landscape.

Land cover data may be used in conjunction with land use metadata and planimetric data to classify tree canopy into useful subcategories such as early successional canopy, tree canopy over turf, tree canopy over impervious surfaces, and tree canopy over buildings. Taking time to classify these gradations provides a better understanding of the relative composition of distinctly different tree canopy types such as native forests; forest remnants mixed with planted trees, and urban tree canopy.

Although some COG jurisdictions may elect to conduct their own land cover/land use analysis, the Chesapeake Conservancy, U.S. Geological Survey, and University of Vermont Spatial Analysis Lab are collaborating, with funding from the Chesapeake Bay Program (CBP), to produce 1-meter resolution land cover and land use/land cover datasets for the Chesapeake Bay watershed regional area, including the entire COG landmass. The CBP 1-meter land cover/land use (LULC) data has over 50 unique classes. LULC data derived from 1-meter RGB satellite imagery acquired in 2013/2014 and 2017/2018 is available to download via a web-based app using the link provided below with updated LULC data based on 2021/2022 imagery expected to become available in the 2024/2025 timeframe. The CBP LULC data can be accessed here: https://cicgis.org/portal/apps/webappviewer/index.html?id=bdf7ca3e249a40fd9a9d83d6e16100ea&extent=-88.252,35.0981,-62.3462,45.7489

The 2017/2018 LULC classifies tree canopy as

- Tree Canopy over Impervious
- Tree Canopy over Turf Grass
- Forest
- Tree Canopy, other
- Harvested Forest
- Natural Succession

These categories are useful in devising different objectives and management plans for different types of tree canopy and forest communities which often require different approaches to conservation. Once the baseline is identified and verified for accuracy, it is possible to begin determining the canopy goal that is right for your community.

STEP 2. Identify Tree Canopy gain/Loss Trends:

This step compares leaf-on imagery and land cover data representing the same geographic area at different dates to detect the amount of change that has occurred within the specified timeframe. Change detection analysis is used to document gain/loss trendlines; delineate specific areas of canopy that have been lost, remained constant, or expanded; and to identify how specific land use changes have impacted canopy coverage. Change detection analyses between two or more data acquisition dates can project how canopy levels will change within the foreseeable future (i.e., 0 to 5 years) with reasonable accuracy. Identifying areas of potential canopy gain on specific properties is a useful by-product of this analysis and provides some of the data required in *STEP 6* (*Identify areas where it is possible to expand canopy levels through tree planting*).

STEP 3. Estimate the Level of Services and Benefits Provided by Your Trees and Forests:

Trees and forests typically provide significant levels of environmental and socioeconomic services. (See Part 1: *A Case for Conserving Trees and Forests in the Metropolitan Washington Region* for a comprehensive discussion of services and benefits provided by trees and forests). In addition to identifying their canopy cover baseline and gain/loss trends, some communities take steps to estimate the level of environmental and socioeconomic services and monetary equivalents provided by their current tree canopy. These estimates are then projected to determine how different canopy gain/loss would impact the delivery of those services and values.

This type of analysis can help identify the level of tree canopy needed to support broader environmental and socioeconomic goals such as those focused on air and water quality improvements and environmental equity. Several tools are available to assess the level of services and values associated with specific areas of tree canopy. A prime example is the iTree Software Suite which was developed by the USDA Forest Service. iTree provides free software and support to evaluate the services and values of both individual trees and large areas of trees at different geographical scales based on peer-reviewed science. More information can be found at: https://www.itreetools.org/

Awareness of tree services and associated values may prompt additional questions such as "what is the minimal amount of canopy needed to sustain acceptable levels of tree services?" or "what level of tree canopy is needed to optimize the delivery of tree services while not incurring unacceptable levels of costs and risks? Although the RTCS recommends *optimizing* tree canopy levels in all COG member communities, this does not necessarily involve *maximizing* tree canopy levels at every opportunity. To determine if a specific percentage represents the optimal level of effort, goal planners should weigh the level of tree services that would be provided at different levels of canopy against the potential costs, damages, and risks that could be incurred at those levels.

STEP 4: Identify Areas of Existing Tree Canopy That Are Currently Protected:

This step begins by locating, measuring, and compiling the total area of tree canopy that is currently afforded protection through various long-term legal mechanisms. Examples include canopy located in parkland, natural resource protection and management areas, watershed protection easements, dedicated open space, and conservation areas. These properties may be protected from disturbance in perpetuity by easement language, deed restriction, or other binding development conditions tied to the land. Mapping these areas will reveal the backbone of tree canopy that has an excellent chance of remaining intact while the community works towards meeting the overall goal through additional tree preservation and planting elsewhere.

STEP 5: Forecasting Post-Development Canopy Levels:

Probable post-development canopy levels for A) recently developed properties and B) properties subject to future development can be forecasted with a reasonable level of certainty using data provided in Table 9: Smaller Scale Tree Canopy Target Goal Levels Recommended for Land Uses which is part of Part 2 of this report. The percent of canopy data found in this column may be used to approximate canopy levels 40 years after land development has occurred based on actual canopy levels observed in a range of land uses using Chesapeake Bay Program Land Use/Land Cover data processed from 2017 and 2018 one-meter satellite imagery.

This step may also include an analysis of possible gains/losses associated with transportation, utility easement, and timber harvest plans. Linear projects involving construction of transmission lines and underground utilities can involve significant loss of tree canopy, but goal planners should not overlook associated reforestation/landscape plans that might mitigate these losses. The composite area of canopy identified in this process should be tallied and added to the area of protected canopy identified by *STEP 4*.

Forecasting Post-Development Canopy Level can be achieved by following the steps:

A) Identify properties that have been recently developed.
B) Identify properties that are subject to development within the period covered by the canopy goal (e.g., 10, 20, or 30-year time frame).
C) Forecast probable post-development canopy levels for both sets of properties.
D) Compile forecasted canopy areas into a total area of tree canopy; and,
E) Add the total area of forecasted canopy to the area of protected canopy identified in *STEP 4*.

These above actions typically require access to GIS datasets to research zoning designations of individual properties. Access to the most current comprehensive land use plan and related documents is a necessity. Some communities may decide to forego *STEP 5* due to the vigorous analysis required or the degree of uncertainty surrounding the direction of land use change. However, this analysis may prove very useful in communities where land use has stabilized and is not likely to change significantly within the time frame of the canopy goal.

STEP 6: Identify Potential Areas to Plant Trees

This step analyzes land cover, tree cover, land use metadata and planimetric data to locate areas that currently lack tree canopy and where it is *possible to gain canopy* through tree planting. In turn, this geographic information may be used to identify potential opportunities to plant trees in support of:

- Physical and psychological health
- Environmental justice
- Urban heat island mitigation and energy conservation
- State Implementation Plan (SIP), (as voluntary air quality improvement measure)
- Stormwater management
- Lower crime
- Economic considerations (e.g., real estate values, retail sales, tourism, commercial districts)
- Establishing/expanding wildlife corridors and habitat
- Community walkability
- Other unique local considerations

Prioritization of planting projects should be determined locally based on the degree of emphasis placed locally on the goals, plans, and policies described in *STEP 8*, and the degree of program capacity and levels of community support described later in *STEP 9* and *10*.

STEP 7. Identify a Potential Canopy Goal:

Add the total area of canopy represented by protected canopy (*STEP 4*); the total area of possible canopy preserved through future efforts (*STEP 5*), and the total area of canopy expanded through tree planting (*STEP 6*). The total represents the level of tree canopy that is possible to achieve within specific timeframe and within the designated area of interest. However, what may be possible will need to be balanced by what is feasible by considering the opportunities, constraints and realities described in *STEPS 8, 9, & 10* before an optimal level of canopy can be identified.

STEP 8: Integrating Tree Canopy Goals:

Determine how the tree canopy goal will support a broader set of goals, plans, and policies That have potential to interact directly or indirectly with tree conservation efforts. The assessment should include a review of the following:

- Climate action plans
- Mission and operations of natural resource management agencies, boards & commissions
- Environmental policies, goals, regulations, and issues
- Land use definitions and documents
- Zoning regulations
- Economic policies
- Budget documents
- Transportation plans
- Tourism plans
- Watershed management plans
- Utility easement vegetation management policies
- Hazard tree removal laws and policies

STEP 9: Gaining Local Government Support of the Tree Canopy Goal:

The assessment should examine the capacity of governmental tree programs to support canopy goal planning and implementation activities.

- What is the primary focus of the local tree program? Is the program currently involved with land use planning and land development review, or will its mission need to be modified to facilitate canopy goal planning and monitoring?
- Are staffing levels adequate to support canopy goal activities and programs?
- Does staff have the skills, knowledge, and abilities required to support all aspects of implementing the goal?
- Are these programs currently funded at the levels needed to support implementation or will a long-term budget processes be needed?
- This assessment is critical to establish a strong foundation for implementing and achieving the goal, especially if a specific date is set to reach the goal.

Also, it is important to determine how much the existing canopy is protected and could be expanded on publicly owned property, (e.g., parks, schools, fire stations, water treatment plants, government centers, etc.). Public property ownership rarely exceeds 20 percent of the total jurisdictional landmass, and much of that property may already be designated for operational activities that will limit tree planting. Goal planners should not assume they understand the functionality or use of properties under the management of public agencies based on the appearance of open space in aerial imagery. Each agency should be contacted individually to ensure that new tree planting projects will complement facility uses.

STEP 10: Public Engagement – Creating a Sense of Ownership in the Community

This aspect of canopy goal planning and preparation may be the single most important aspect to identify a realistic canopy goal. Gauge the capacity and willingness of the community and potential partners to support the tree canopy goal. Local government cannot support canopy goals without community participation. This is especially true given that properties with the greatest potential to expand canopy are usually privately-owned. Goal planners must determine ways to inspire and engage the community at large.

Understanding community demographics is also necessary to gauge the likelihood of community support for initial adoption of the canopy goal and its implementation over time. Demographic data can be used to target groups that are likely to participate in tree planting and related activities; and, to create effective marketing strategies.

Goal planners should compile a list of regional non-profit tree organizations and environmental groups that would generally support a canopy goal, and then hold discussions with these groups to gauge levels of interest and support. Non-profit organizations are often more skillful at public outreach and education than local governments and may be willing to enter partnerships to gather inventory data, refine and lead tree planting projects, produce nursery grown trees and seedlings, hold education and outreach events, and promote the goal via social media.

Finally, goal planners should contact local and state nursery industry organizations to inquire about the availability of trees at volumes required to support the levels of annual tree planting that may be required. These groups may also be interested in entering partnerships promoting the goal via tree discounts, newsletters, social media, etc.

FINAL STEPS

The final steps of determining the optimal canopy level involve synthesizing the results of STEPS 1 through 10 and converting the product into a preliminary goal. The preliminary goal and associated data and justification would then be vetted with stakeholder groups for review and comment. Incorporate feedback and adjusted as needed to the preliminary plan/goal prior to proposing the goal to local policy makers for their consideration.

APPENDIX

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Charles County, Maryland Tree Cover Status and Change (windows.net)

Frederick County, Maryland Tree Cover Status and Change (windows.net)

Montgomery County, Maryland Tree Cover Status and Change (windows.net)

Prince George's County, Maryland Tree Cover Status and Change (windows.net)

City of Alexandria, Virginia Tree Cover Status and Change (windows.net)

Arlington County, Virginia Tree Cover Status and Change (windows.net)

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City of Falls Church, Virginia Tree Cover Status and Change (windows.net)

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City of Manassas, Virginia Tree Cover Status and Change (windows.net)

City of Manassas Park, Virginia Tree Cover Status and Change (windows.net)

Prince William County, Virginia Tree Cover Status and Change (windows.net)

Resolution Establishing the Regional Tree Canopy Subcommittee

Resolution R7-2019
February 13, 2019

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS 777 NORTH CAPITOL STREET, NE

WASHINGTON, DC 20002

RESOLUTION ENDORSING THE ESTABLISHMENT OF A REGIONAL TREE CANOPY SUBCOMMITTEE OF THE CLIMATE, ENERGY, AND ENVIRONMENT POLICY COMMITTEE (CEEPC)

WHEREAS, in 2008 the Metropolitan Washington Council of Governments (COG) Board of Directors adopted a regional greenhouse gas report and set emission reduction targets of 10 percent below business as usual projections by 2012, 20 percent below 2005 levels by 2020, and 80 percent below 2005 levels by 2050, and assigned the CEEPC to implement measures to achieve the target; and

WHEREAS, state and local governments and private organizations have recognized the host of environmental benefits that trees provide and that there is a vested interest and investment in the sound management and protection of forests, urban forests and other green infrastructure such as community parks, recreation areas, riparian buffers; and

WHEREAS, the Regional Tree Canopy Management Strategy provides guidance to conserve, protect and enhance regional urban forest canopy and managing this resource to protect the quality, health and functionality of urban forests, consistent with COG's Region Forward vision; and

WHEREAS, a key recommendation of the Regional Tree Canopy Management Strategy is to establish a committee to advise COG on related issues, trends and policies and to work towards the goals established in the Strategy; and

WHEREAS, CEEPC requests the COG Board of Directors endorse the establishment of a Regional Tree Canopy Subcommittee as a technical subcommittee of CEEPC; and

WHEREAS, the Subcommittee would be comprised of regional subject matter experts, appointed by the CEEPC chair as is provided in the CEEPC bylaws, representing local, state and federal interests in forestry, climate change, and water and air quality to assist CEEPC in working towards the goals identified in the Tree Canopy Management Strategy.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF THE METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS THAT:

The board endorses the establishment of a Regional Tree Canopy Subcommittee of CEEPC for a two-year period ending in December 2020 (with the option to extend by the board), which would be charged with protecting, managing, and expanding urban forestry assets for health and quality of life; optimizing urban forest programs; developing a regional urban forest action plan and canopy goals; inspiring the community to take ownership of efforts to protect and expand urban forests; and integrating urban forestry with Region Forward and meeting Chesapeake Bay water quality goals.

I HEREBY CERTIFY THAT the foregoing resolution was adopted by the COG Board of Directors on February 13, 2019.

Laura Ambrosio, COG Communications Specialist

Examples of Current Tree Canopy Goals and Tree Conservation Programs in the Region

REGIONAL

Metropolitan Washington Council of Governments (COG)

- Metropolitan Washington 2030 Climate and Energy Action Plan, 2020
    - Recommends enhancement of regulatory capacity to manage tree canopy and forest protection
    - Recommends member jurisdictions adopt tree canopy/forest cover goals
    - Supports increasing overall regional tree canopy cover 2.4 percent above 2012 levels by 2030
- Tree Canopy Management Strategy, 2018

DISTRICT OF COLUMBIA

Washington D.C. Government

- Sustainable DC 2.0, 2019
    - 40 percent tree canopy cover by 2032
    - Tree planting target of 10,500 per year
- Tree Report Card, 2022
- DC State Forest Action Plan, 2021
- My City's Trees
- Urban Tree Canopy Plan, 2013

MARYLAND

State of Maryland

- 5 million Trees Initiative
    - Plant 5 million trees in Maryland by 2031
- Technical Study: Changes in Forest Cover and Tree Canopy, 2022
- Forest Preservation Act of 2013; HB 706
    - No net forest loss

City of Bowie

- Urban Tree Canopy Goal Resolution, 2012
    - 45 percent tree canopy goal

- No Net Loss Policy, 2022
- Sustainability Action Plan, 2016, updated 2020
    - Includes 45 percent tree canopy goal
- Urban Greening Strategy Report, 2011
- Tree City USA

Charles County

- In process of evaluation to determine goal

City of College Park

- City of College Park Strategic Plan for 2021-2025
    - 40 percent tree canopy by 2025
- Tree and Landscape Maintenance, Ordinance 21-0-09, 2022
- Urban Forest Protection Recommendations, 2021
- Tree Canopy Assessment Report, 2018
- Tree Canopy Enhancement Program
- Tree City USA

City of Frederick

- Urban Forestry Management Plan, 2019
    - 40 percent tree canopy cover goal
- Tree Frederick Program
- Tree Canopy Report, 2016
- Urban Tree Canopy Report, 2008
- Tree City USA

Frederick County

- Urban Tree Canopy Assessment, 2017 (Published 2017, data 2012/2014)

City of Gaithersburg

- Tree City USA

City of Greenbelt

- Chesapeake Bay Urban Tree Canopy Goal Member, 2003
    - *In process of assessing existing and potential UTC*
- Street Tree Inventory, 2013
- Tree City USA

City of Hyattsville

- Chesapeake Bay Urban Tree Canopy Goal Member, 2003
    - *In process of assessing existing and potential UTC*
- iTREE Report, 2007
- Tree City USA

City of Laurel

- Tree City USA

Montgomery County

- Montgomery County Climate Action Plan, 2021
    - Action to 'Retain and Increase Tree Canopy'
    - Currently 46.7 percent urban tree canopy
- Montgomery County Forest Conservation Law, 2023
    - 'No Net Loss of Forest' goal
- Montgomery County Forest Conservation Regulations, 2021
- Tree Canopy Conservation Law, 2013
    - Tree Canopy Law FY22 Annual Report
- Tree Montgomery Program
- Tree Canopy Explorer Map
- Reforest Montgomery
- Tree City USA

Prince George's County

- Climate Action Plan, 2022
    - Maintain 52 percent tree cover through 2030
    - Increase tree cover to 55 percent by 2050
    - Recommends action to adopt Countywide No Net Tree Loss strategy to preserve existing tree canopy and which weights EEA communities
- Plan 2035
    - 'No-net-loss" goal to maintain forest and tree canopy
- Resource Conservation Plan, 2017
- Forest Canopy Assessment, 2013
- Tree ReLeaf Grant Program
- Tree City USA

City of Rockville

- Climate Action Plan, 2022**
    - Policy 10: Preserve and enhance tracts of contiguous forest areas and tree canopy
    - Policy 11: Continue to assess tree canopy coverage

- Master Street Tree Plan, updated 2023
- Chesapeake Bay Urban Tree Canopy Goal Member, 2003
    - In process of assessing existing and potential UTC
    - RainScapes Rebate Program
- Tree City USA

City of Takoma Park

- Goals and Principles for Tree Canopy Urban Forestry
    - Goal of no net loss of the urban forest canopy, with the baseline measurement at approximately 60 percent tree canopy coverage citywide
- Sustainability and Climate Action Plan, 2019*
    - Includes recommendation to continue to expand tree canopy to mitigate the urban heat island effect
- Urban Forest Master Plan, 2023
- City Tree Programs
- Tree City USA

VIRGINIA

Commonwealth of Virginia

- Virginia Department of Forestry Strategic Plan, 2020
- SB537, HB1346, 2022
    - Law allows localities across Virginia to conserve and expand tree cover in specific cases, no requirement
    - Increases flexibility for implementation and management of tree canopy banks, tree canopy credits, and tree canopy requirements

Chesapeake Bay Program

- Chesapeake Bay Urban Tree Canopy Management Strategy 2015-2025
    - Expand urban tree canopy by 2,400 acres by 2025

City of Alexandria

- Tree Canopy Assessment, 2022
- Environmental Action Plan 2040, 2019
    - Increase tree canopy coverage to 40 percent by 2035

    - Maintain ratio of 7.3 acres of publicly accessible open space per 1,000 residents
- Urban Forestry Master Plan, published 2009, updated 2016
    - Plant 400 additional trees per year
    - Recommendation to adopt tree canopy coverage goal of 40 percent
- Tree City USA

Arlington County

- Forestry and Natural Resources Plan, 2022
- Urban Tree Canopy Assessment, 2017
    - Maintain 40 percent county-wide tree canopy goal
    - Provide 30 percent tree canopy in all public spaces
    - Provide 15 percent tree canopy in commercial spaces
- Tree Canopy Coverage Map, 2011
- Urban Forest Master Plan, 2004
    - 40 percent overall tree canopy goal
- Tree City USA
- ReLeaf Partner

City of Falls Church

- 50 percent tree canopy goal

- Neighborhood Tree Program
- Annual Report of the Urban Forestry Commission, 2021
- Tree City USA
- *Working to develop an Urban Forestry Management Plan**

Fairfax County

- Fairfax County CECAP Implementation Plan - Expand the tree canopy to 60% with a minimum of 40% tree canopy coverage in every census block by 2030 and a minimum of 50% tree canopy coverage in every census block by 2050, prioritizing areas of highest socioeconomic need first. https://www.fairfaxcounty.gov/environment-energy-coordination/sites/environment-energy-coordination/files/Assets/documents/CECAP/CECAP%20Implementation%20Plan%201623_A-1a.pdf

- Fairfax County Tree Action Plan, 2019
    - No net loss; maintain 57 percent tree canopy
- Urban Tree Canopy Assessment, 2017
- Tree Canopy Report, 2013
- Tree Conservation Ordinance, 2009
- Tree City USA

City of Manassas

- 2040 Comprehensive Plan, 2020

    - Provision to update the City's urban tree canopy study and establish targeted goals to increase coverage
- Tree City USA

City of Manassas Park

- Tree Canopy & Landscape Zoning Ordinance, 2022

Prince William County

- 2021 iTree Ecosystem Analysis Prince William County https://www.pwcva.gov/assets/2021-05/PWCi-TreeReport2019-2020.pdf
- Prince William County Division of Environmental Management https://www.pwcva.gov/department/environmental-services
- Prince William County Forest Pest Management Program https://www.pwcva.gov/department/construction-operations/about-mosquito-and-forest-pest-management-branch
- Buffer Areas, Landscaping and Tree Cover Requirements https://www.pwcva.gov/assets/2021-04/dcsm800_0.pdf

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