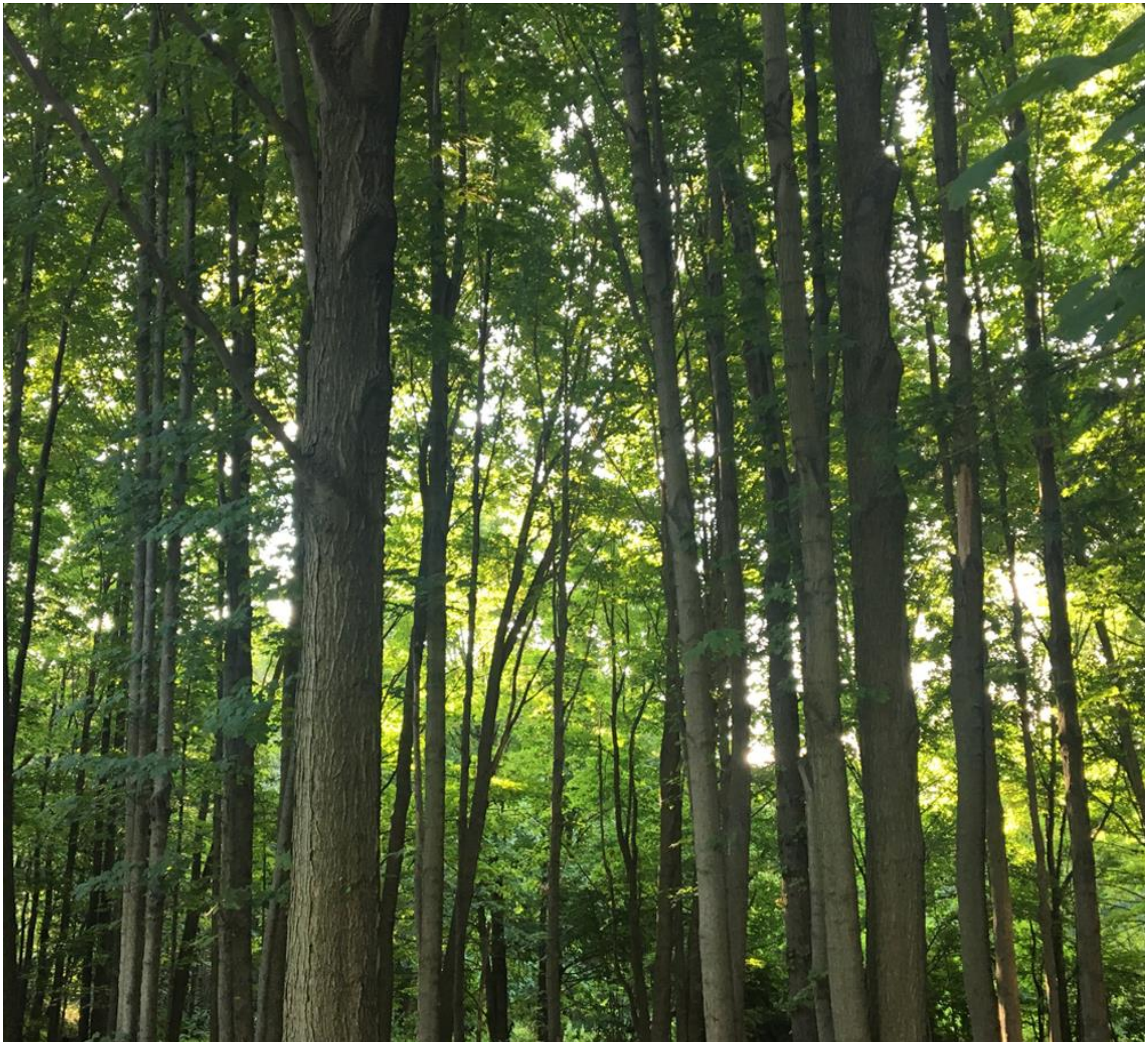


Tree Canopy Analysis

for the Western Connecticut Region

2018

WESTCOG

Contents

Introduction

Welcome to the Western Connecticut Council of Governments' (WestCOG) Regional Canopy Analysis. This document provides Region with vital information on the benefits and potential of the Region's current tree canopy.

Funding for this project came from an American the Beautiful Grant managed by the Connecticut Department of Energy and Environmental Protection (CT DEEP). This document was prepared by WestCOG. The opinions, findings, and conclusions expressed in this publication are those of WestCOG, and do not necessarily reflect the official views or policies of CT DEEP.

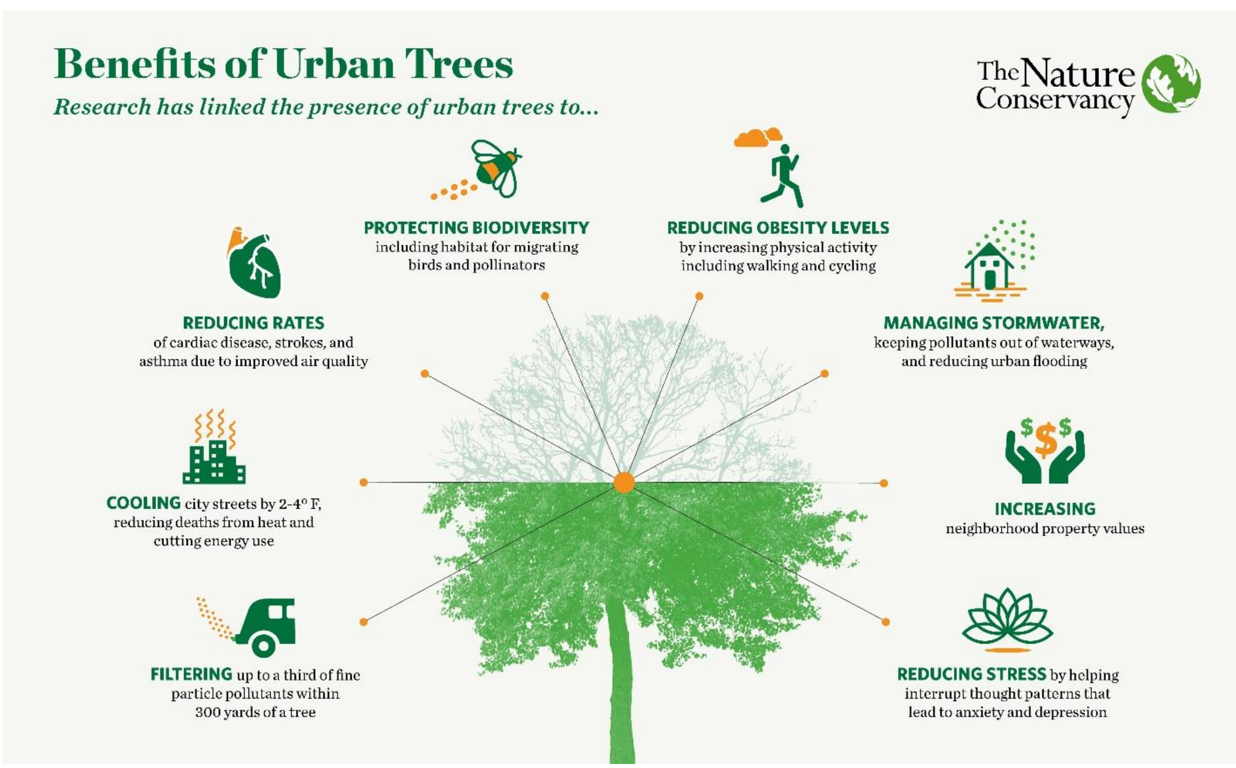
Source: Norwalk Tree Alliance

Benefits of Trees

Trees are key to a healthy city. A flourishing urban tree canopy provides an array of benefits and services. These fall under three main categories:

- Environmental services – stormwater mitigation, air quality mitigation, ecological balance;
- Social enhancement – improved mental and physical health, contributing to a sense of place;
- Economic growth – increased housing prices, amplified commercial income.

These benefits give cities strong incentives to maintain a robust tree canopy. Understanding the positive outcomes of planting trees and embracing the importance of trees in the urban landscape can help improve the condition of communities across the United States.



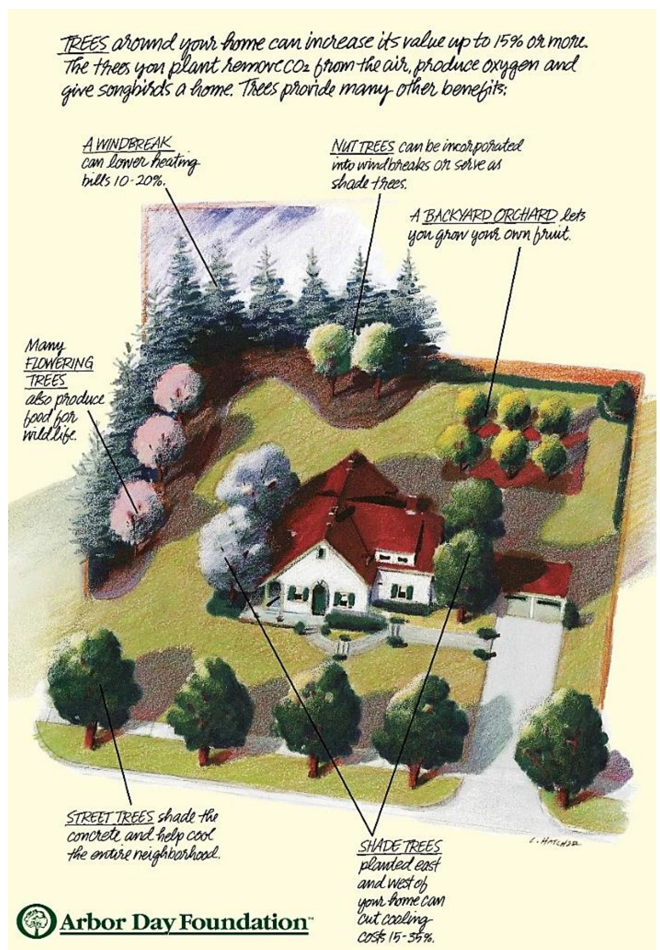
Temperature & Microclimate

Cities tend to be hotter than suburbs and rural areas. This is partly because urban environments have a greater percentage of impervious surfaces, such as paved roads, sidewalks, parking lots, and roofs. These sealed surfaces absorb sunlight, and as they heat up, they warm the surrounding air, contributing to the urban heat island effect.

The EPA describes a heat island as a built-up area that is hotter than the nearby rural areas. Their website states, "[t]he annual mean air temperature of a city with 1 million people or more can be 1.8 – 5.4°F (1 – 3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C)." Urban heat islands can increase peak energy demand and air conditioning costs during warmer months. They can increase air pollution and greenhouse gas emissions, instances of heat-related illness and mortality, as well as negatively impact water quality.

Research from NASA (2015) shows that the daytime temperature difference between urban and vegetated land remains stable at 1.3°C [2.3°F], until the impervious cover on urban lands exceeds 35% of the land area, at which point the difference in temperature between vegetated land and urban land increases to 1.6°C [2.9°F]. According to NASA, "a rise of 1°C [1.8°F] can raise energy demands for air conditioning in the summer from 5 to 20 percent in the United States…. So even though 0.3°C [.5°F] may seem like a small difference, it still may have impact on energy use, …. especially when urban heat island effects are exacerbated by global temperature rises due to climate change."

Trees can reduce the amount of heat absorbed by impervious surfaces and mitigate the urban heat island effect by shading streets and buildings. Thus, the demand for and the cost of air conditioning decreases along with energy use. The shade provided by trees can reduce air temperatures by up to 9°F (5°C). Through evaporation, a tree's release of water vapor further reduces air temperatures. Trees release excess water into the air as vapor through pores, or stomata, on leaf surfaces. As the vapor is released, it cools the surrounding air. This can reduce noon time peak temperatures by an additional 3.5°F to 5.5°F (1.9°C to 3.1°C). By providing shade and releasing water vapor, trees cool urban environments and reduce cooling costs.



Trees also reduce heating costs in the winter. Trees act as a wind barrier and can reduce wind speed by up to 60%. This prevents cool winter air from entering interior spaces, thereby reducing heating costs. For instance, a 50% wind speed reduction yields a 7% reduction in heating energy.

To reduce cooling and heating costs, and save energy, it is best to plant deciduous trees on the east and west sides of buildings. Deciduous trees' loss of leaves in the fall allows more sunlight to reach building roofs when such heat can be the most beneficial. This allows trees to cast shade in the summer while enabling the sun to warm the building in the winter. To block wind and prevent cold air from penetrating interior spaces in the winter, evergreen trees should be planted on the north side of buildings.

Carbon Storage

Cities with traffic congestion, industrial activities, power plants, and other carbon emission sources release large amounts of carbon dioxide. Many urban areas are recognized as carbon "hot spots" because there tend to be a release of larger amount of carbon. The increased carbon dioxide emissions form a dome over cities, increasing temperatures that in turn lead to increased concentrations of air pollutants which are harmful to human health.

As previously noted, trees can reduce the need for heating and cooling. As a result, power plants can decrease energy production and reduce the quantity of greenhouse gases released into the atmosphere. Planting an average of four shade trees per house is shown to decrease energy demands and lead to an annual carbon emissions reduction from power plants of 9,000 to 41,000 tons (Akbari, 2002).

Trees also actively absorb carbon from the air. The term "carbon sequestration" is used to refer to the process in which carbon dioxide is removed from the atmosphere and stored. Using energy from the sun, trees react carbon dioxide with water to create sugar. While much of the sugar is used by the tree for energy, the rest (carbon included) is stored in the tree as structure. Sequestered carbon makes up 45% of the dry weight of the plant, with large healthy trees storing the greatest amount of carbon (Nowak and Crane, 2002).

It is important to note in some cases, trees contribute to increased atmospheric carbon. This is because activities associated with tree maintenance, including the use of chain saws, chippers, stump removers, and trucks used to transport the machinery, burn fossil fuels and emit carbon dioxide into the air.

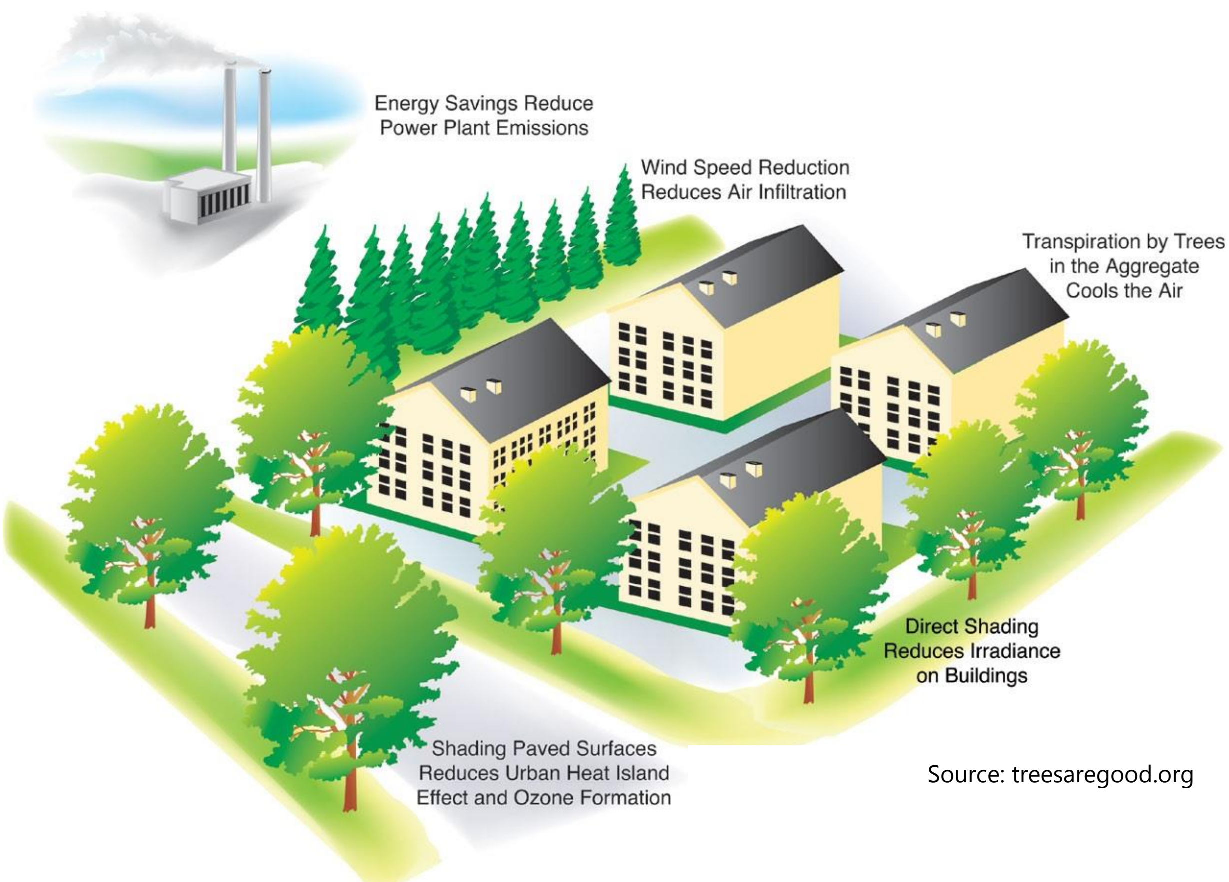
Air Quality

Due to high concentrations of traffic and industry, air quality is often significantly worse in cities than in a state or county. Consequently, pollution-related illnesses, which include upper and lower respiratory symptoms, bronchial asthma, lung function deficits, and air pollution related cancers, are more prevalent in urban areas. The pollutants of greatest public health concern are particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide. Trees improve urban air quality by removing these harmful pollutants from the air and preventing the formation of compounds.

Trees remove air pollution in two ways, through uptake and interception. During uptake, stomata open during the day. This allows air, and airborne pollution, to move into the leaf. Once inside, some of the pollutants are trapped in the tree. The tree then releases oxygen into the atmosphere, further purifying the air. During interception, particulate matter, which includes soot, ash, and dust, adheres to the tree's surface. This reduces the local concentration of airborne particulate matter.

In addition to filtering out and trapping air pollutants, trees inhibit their formation altogether. As previously discussed, trees reduce air temperatures by providing shade and emitting water vapor. Some pollutants, such as ozone, require elevated temperatures to form. By lowering the air temperature, trees limit the formation of some pollutants. With fewer pollutants in the air, the air quality in urban areas improves, therefore reducing harmful impacts on human health.

While trees play a significant role in improving air quality, care must be taken to ensure low pollen producing and low volatile organic compound emitting trees are planted. This will minimize any potential negative effects and maximize the air purifying potential of trees.



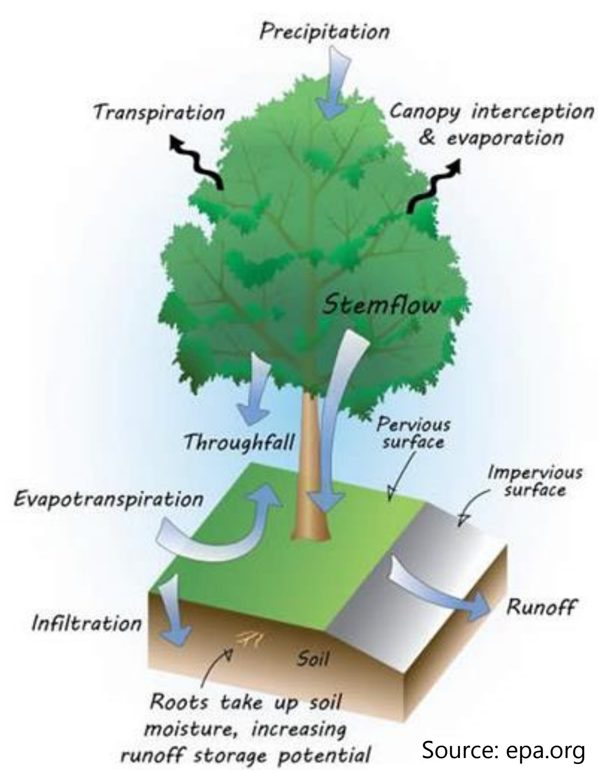
Source: treesaregood.org

Stormwater

While cities typically promote more efficient and environmentally friendly use of land, energy, and materials than spatially-extensive suburban or rural developments, they also tend to have higher concentrations of impervious surfaces. Impervious surfaces are surfaces made of impenetrable materials such as concrete and asphalt, and they significantly impact the water cycle. Impervious surfaces prevent stormwater infiltration, diverting runoff directly into drainage infrastructure or surface waters. Not only does this increase in stormwater volume lead to severe flooding issues in many communities, but it is also one of the top contributors to water quality degradation nationwide. As stormwater moves across surfaces such as roads, parking lots, and lawns, it picks up pollutants and carries them into rivers, streams, ponds, and lakes. Research from the Office of Coastal Management indicates that the quality of surface water becomes significantly degraded with as little as 10% impervious cover in the drainage basin or watershed.

Healthy tree coverage can reduce stormwater runoff and peak flows in local waterways, resulting in substantial savings on drainage infrastructure, water treatment costs, and the need for flood controls. When it rains, foliage intercepts rainfall. The rainwater is temporarily held on leaves and bark where it may later evaporate directly from the tree, flow down the trunk to the ground, or drip off the leaves. This interception slows the rate with which rainwater reaches the ground and reduces the volume of stormwater runoff. This reduces the volume of water being diverted into drainage infrastructure, easing the load placed on aging infrastructure systems and reducing the need for flood controls. With less stormwater entering the drainage system, less stormwater is treated at water treatment facilities. Trees, particularly larger ones, are a cost-effective way to manage stormwater and lessen infrastructure and water treatment expenses.

Trees also improve water quality. The area beneath trees is usually pervious and allows stormwater, along with any pollutants, to infiltrate the soil. Trees' roots take up degraded stormwater. Trees either store the pollutants or transform them into harmless chemicals. This on-site treatment of stormwater can reduce runoff and pollutant loads by 20% to 60%. Remaining stormwater that is not absorbed by trees filters through the soil, recharging the groundwater below.



Source: epa.org

Even though trees play a significant role in mitigating stormwater impacts in the urban environment, proper maintenance is required to ensure tree refuse does not clog pipes and outlets. Care must also be taken so that roots do not puncture underdrains and filter fabric or produce sidewalk heaves, leading to costly repairs. Tree placement should also be considered; trees must be planted in areas where they can most effectively absorb stormwater yet not obstruct utility lines. When properly planted and maintained, these concerns may be mitigated and trees can be used to effectively treat stormwater runoff.

Community Wellbeing

Livable cities are often identified as vibrant, walkable communities with a sense of place. While trees alone cannot make a city vibrant, walkable, or lend it a sense of place, they play a key role in achieving all three goals.

Street trees and the canopy they provide reduce crime. A 2015 study of New Haven, Connecticut found that greater tree canopy cover was associated with lower rates of violent, property and total crime, independent of [other confounding variables.]" Gilstad-Hayden et al found that a 10% increase in tree canopy was associated with a 15% decrease in violent crime, and with a 14% decrease in property crime.

Street trees also buffer pedestrians from the road, making sidewalks safer and more comfortable. Comfort and safety result in more pedestrians using the sidewalks. As the number of people on the street grows, the safety of the street — whether perceived or real — tends to rise, which in turn draws more people onto the street, producing a virtuous circle. A 2008 study by Naderi et al published in the Institute of Transportation Engineers Journal found that "that trees contribute to a sense of safety. The significant reduction in driver speeds in the suburban [model] indicates that street trees may provide positive operational values. Although collisions with trees are horribly fatal, there may be fewer crashes overall."

By encouraging people to travel the streets at human speed, and to interact with each other at a human scale, trees can foster the growth of social capital through interactions on the street. This leads to the development of a sense of identification with and pride in a place. Increased pedestrian traffic also benefits local businesses by increasing exposure. Businesses that are in districts with street trees report higher revenue. Thriving businesses draw additional traffic, which contributes to vibrancy and productivity in commercial corridors.

A 2003 study by Wolf used a national survey to determine public perceptions, patronage behavior, intentions, and product willingness to pay in relationship to varied presence of trees in retail streetscapes, and concluded, "creating and stewarding an urban forest canopy may enhance revenues for businesses in retail districts that offer diverse products at varied prices…." While many conditions contribute to perceptions by consumers of attractive, desirable shopping settings, this study suggests that the urban forest should be a central element of retail place."

Trees also make the city more appealing. Trees convert streets, parking, sidewalks, and alleyways into more pleasant environments by providing shade and screening from or softening of unattractive sights, and to a lesser extent, sounds and odors. Trees' organic shapes, colors, and textures add a natural, humanizing component to the built environment, which in many places consists largely of concrete and asphalt. Trees can also serve as visual markers. Trees can define a diversity of places, from play areas and parks to shopping areas and property lines. Similar to the way architecture can tie a neighborhood together, artistic tree choice or a particular landscape design can be used to provide cohesive aesthetics. Trees were often an identifier of a street's identity and becoming their namesake i.e. Oak Street, Pine Hill Avenue, Chestnut Hill Road, etc.

When an area is well landscaped, it is more attractive and people want to live there. This is best demonstrated by comparing the sale prices of houses. The difference in sale prices between homes with trees versus homes without them represents the willingness of the consumer to pay for the benefits and shoulder the costs associated with trees. A study by Morales (1980) conducted in Manchester, Connecticut found that 6 - 9% of the total sales price of a house could be attributed to good tree cover.

While trees can help make a city vibrant and walkable and lend it a sense of place, making cities more attractive for homebuyers, trees also make communities healthier places to live. Studies in a variety of locations have found a link between exposure to nature and wellbeing. Stress, for instance, is often a health concern in cities. Stress related to urban living, work practices, and hazardous environments contribute to poor mental and physical health, especially among vulnerable segments of the population. Exposure to nature can facilitate the recovery from stress or other problems, make people more resilient against future stress, and enable people to concentrate and think more clearly. Trees play a key role in the urban environment, engendering a vibrant, walkable, and healthy community.

Source: Downtown Northampton Association

Drawbacks of Trees

While the benefits of trees are overwhelming, one would be remiss to not consider the costs. Fallen leaves from deciduous trees clog gutters and storm drains. Roots heave sidewalks and can disrupt other hard infrastructure. Falling branches and trunks can damage property and create dangerous conditions. Tree maintenance and removal can also become contentious issues between municipalities and the public.

In general, larger trees are more expensive to maintain than smaller trees, but increased benefits more than offset the difference. Pruning is usually the single greatest cost, followed by expenditures for tree planting, removal, administration, and hardscape repair. Guidance on how to avoid some of these cost through careful planting can be found in the Appendix A.

Heaving Sidewalk

Current Conditions

Tree Canopy

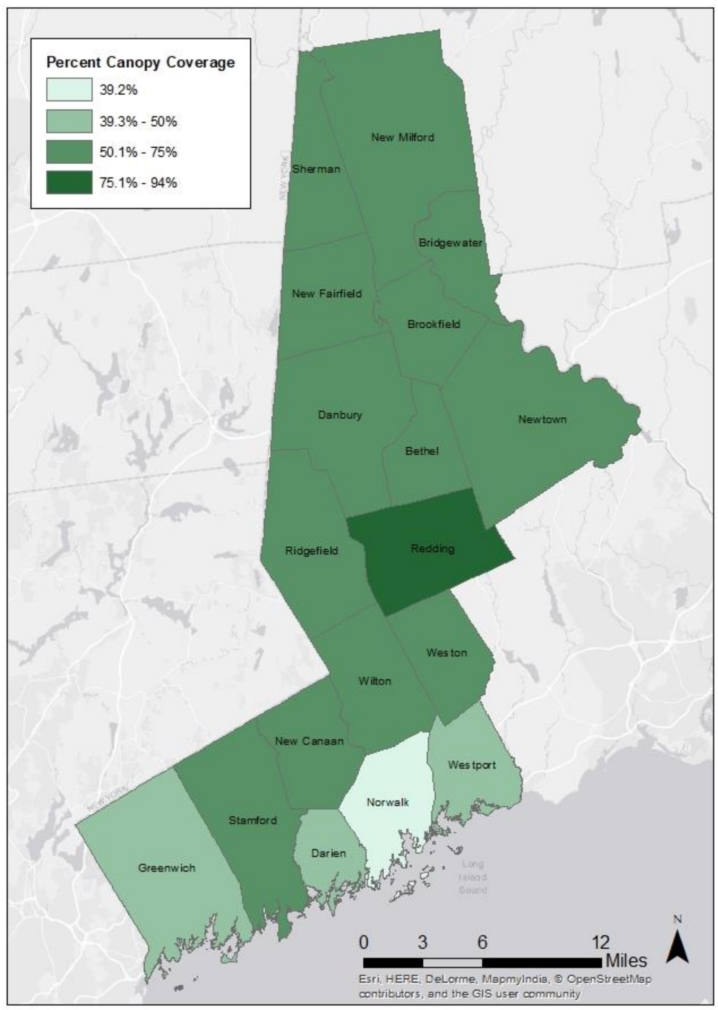
Using imagery from 2015, WestCOG found that 61.5% of the Region is covered in tree canopy. This accounts for 216,643 acres of 352,206 acres. It is estimated this canopy has between 13,091,307 trees. The table below lists canopy coverage by municipality. The three cities in the Region, Danbury, Norwalk, and Stamford, predictably have lower canopy coverage. Westport, Darien, and Greenwich also have low canopy coverage as they are also urbanized areas.

Table 1: Canopy Coverage by Municipality in Western Connecticut

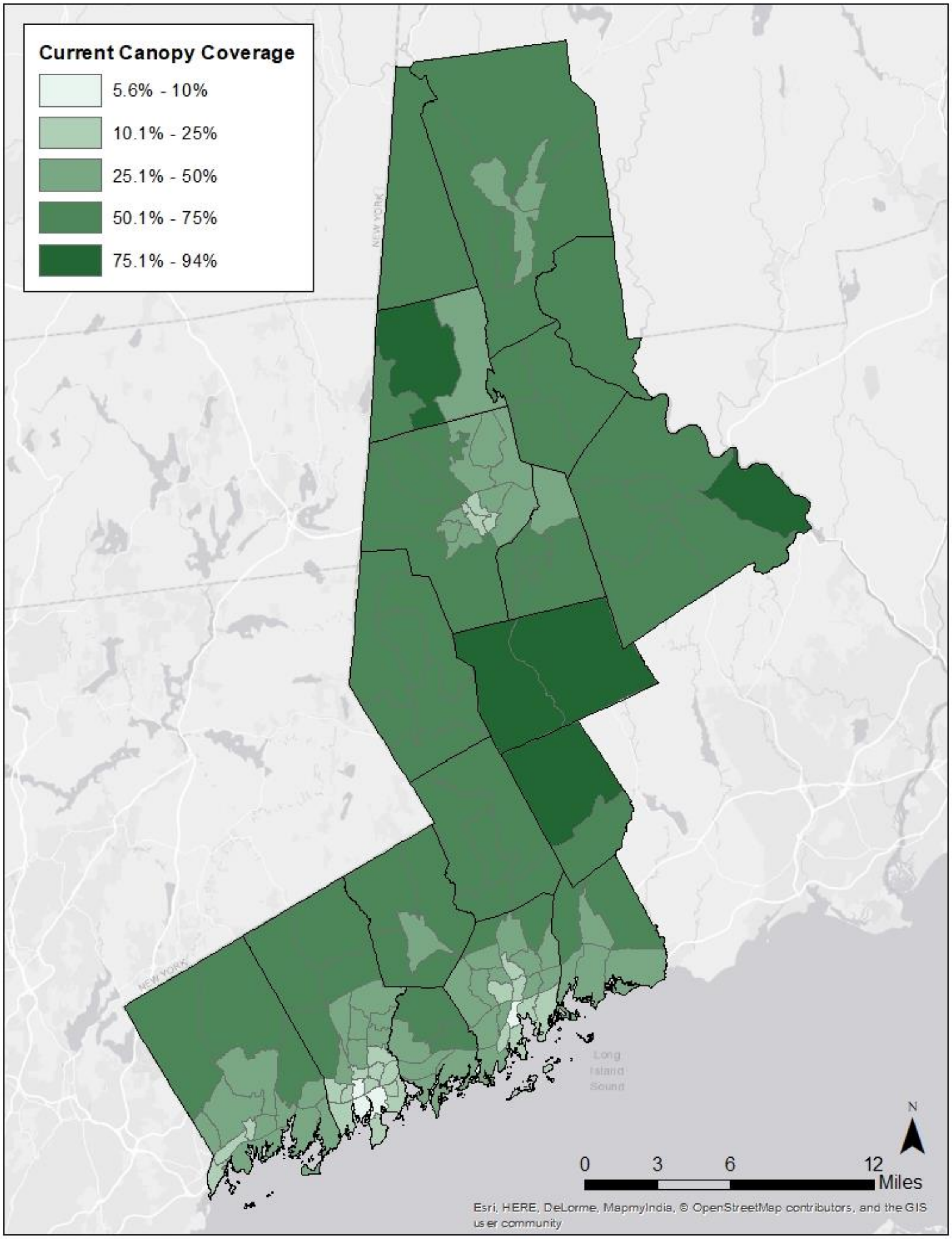
	Percent Canopy Coverage
Norwalk	39.2%
Westport	47.1%
Darien	47.7%
Greenwich	49.4%
Stamford	50.2%
Danbury	52.0%
Brookfield	59.5%
New Fairfield	60.0%
New Canaan	60.5%
WestCOG	**61.5%**
New Milford	62.7%
Bethel	63.8%
Bridgewater	68.1%
Ridgefield	68.5%
Wilton	70.7%
Sherman	71.2%
Newtown	71.5%
Weston	74.7%
Redding	78.3%

When looking at the neighborhood level (Census Tracts) subtleties emerge between the residential areas and commercial areas throughout the region. The Map 2 clearly shows that cities centers in the Region have far less canopy coverage than the neighborhoods just outside of them. Town centers, like in Newtown, New Canaan, and Bethel also tend to have lower canopy coverage than the rest of their respective towns.

Map 1: Canopy Coverage by Municipality in Western Connecticut



Map 2: Canopy Coverage by Census Tract in Western Connecticut



Impervious Surface

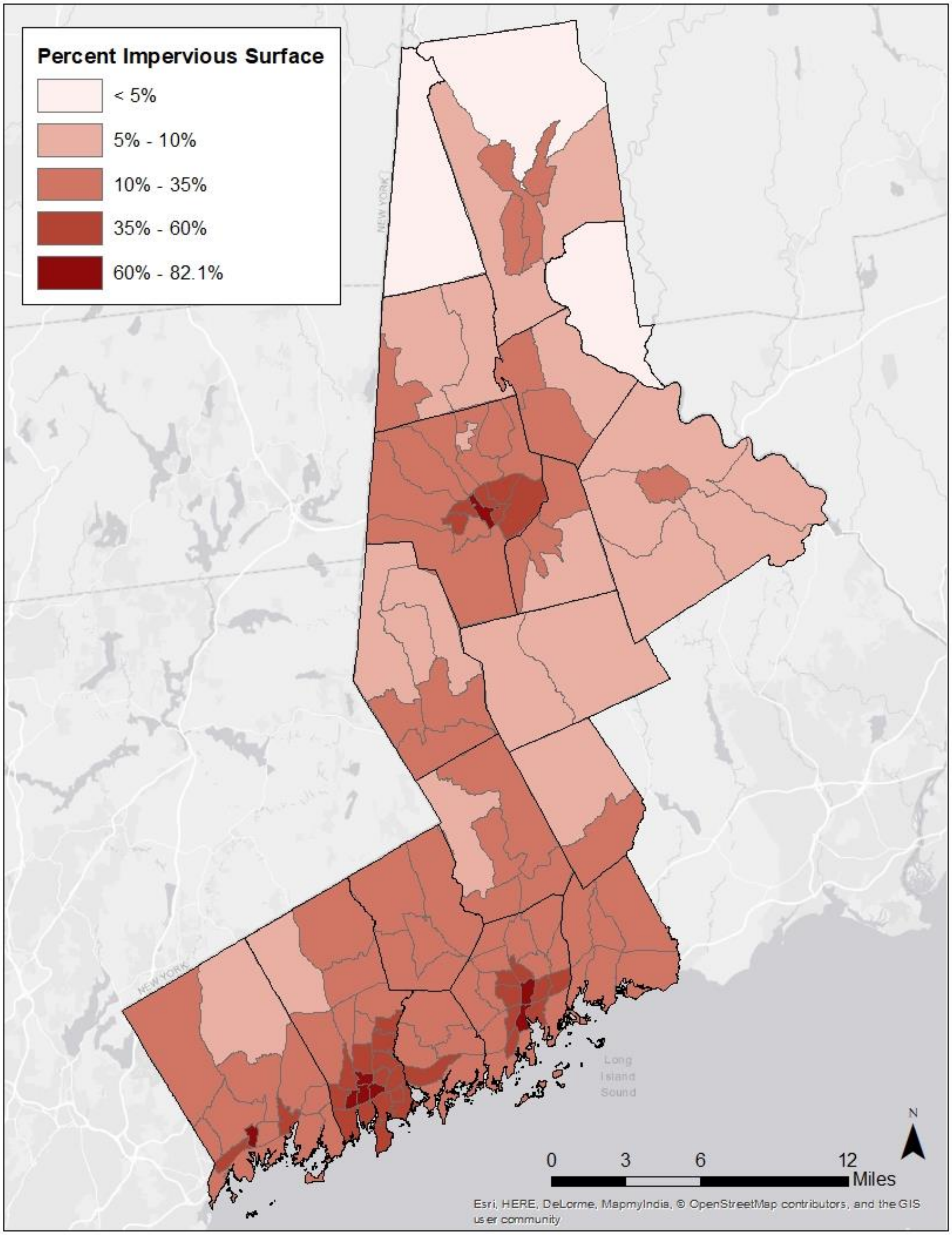
Impervious surface is considered land which water cannot percolate through such as buildings, pavement, and cement. Impervious surfaces are often trees main competitor for space. Using imagery from 2015, WestCOG found that 13.1% of the Region is covered in impervious surface. This accounts for 46,329 acres of 352,206 acres. The table below lists impervious surface coverage by municipality. The three cities in the Region, Norwalk, Stamford, and Danbury predictably have higher impervious surface coverage. Darien, Westport, and Greenwich also have higher impervious surface coverage since they are urbanized areas with a considerable about of transportation infrastructure running through them such as I-95, Route 1, and Metro North.

Table 2: Impervious Surface Coverage by Municipality in Western Connecticut

	Percent Impervious Surface
Norwalk	32.2%
Stamford	25.3%
Darien	21.7%
Westport	21.0%
Danbury	18.5%
Greenwich	17.0%
New Canaan	14.1%
Bethel	13.7%
Brookfield	13.2%
WestCOG	**13.1%**
Ridgefield	11.4%
Wilton	11.2%
Weston	8.9%
Newtown	8.1%
New Fairfield	7.1%
New Milford	6.9%
Redding	6.7%
Sherman	4.0%
Bridgewater	3.3%

When looking at the neighborhood level (Census Tracts) inverse subtleties to the tree canopy emerge between the residential areas and commercial areas throughout the region. Map 3 clearly shows that cities centers in the Region have more impervious surface coverage than the neighborhoods just outside of them. Town centers, like in, New Canaan, Ridgefield, and New Milford also tend to have higher impervious surface coverage than the rest of their respective towns. This pattern also may be due to the considerable about of transportation infrastructure within them, such as parking lots to accommodate visitors to these centers.

Map 1: Impervious Surface Coverage by Census Tract in Western Connecticut



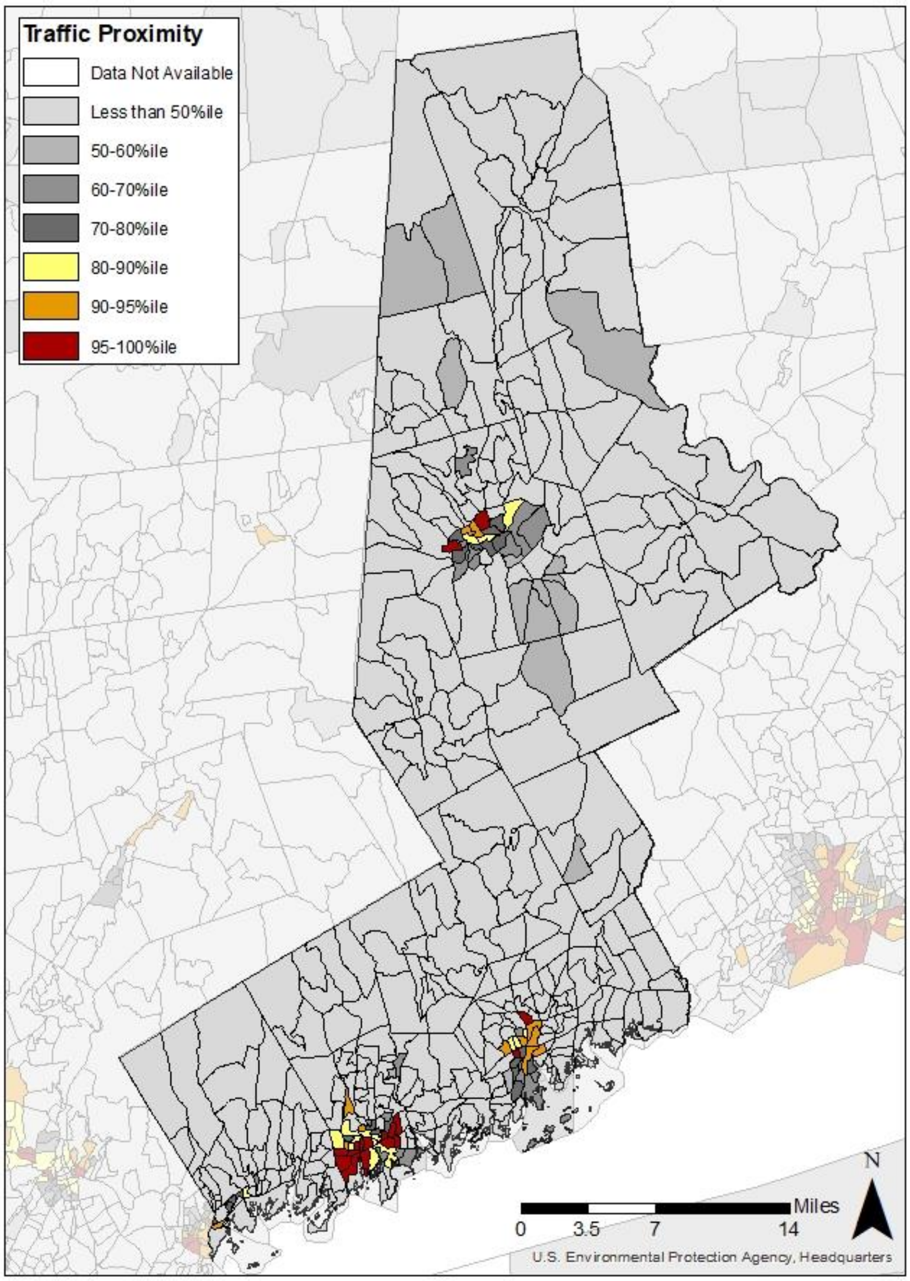
Air Quality

As mentioned previously, the presence or lack of trees can have a significant impact on air quality and health outcomes.

Traffic Proximity

High proximity to traffic can have negative impacts on the land around it. Not only does the traffic necessitate considerable amounts of impervious surface for its use, but traffic also contributes to noise and air pollution. Map 4 displays areas of high traffic proximity compared to other areas in the United States. Urban areas in the Region are within the highest national percentiles. These areas have the highest average annual daily traffic at major roads within 500 meters, divided by distance in meters.

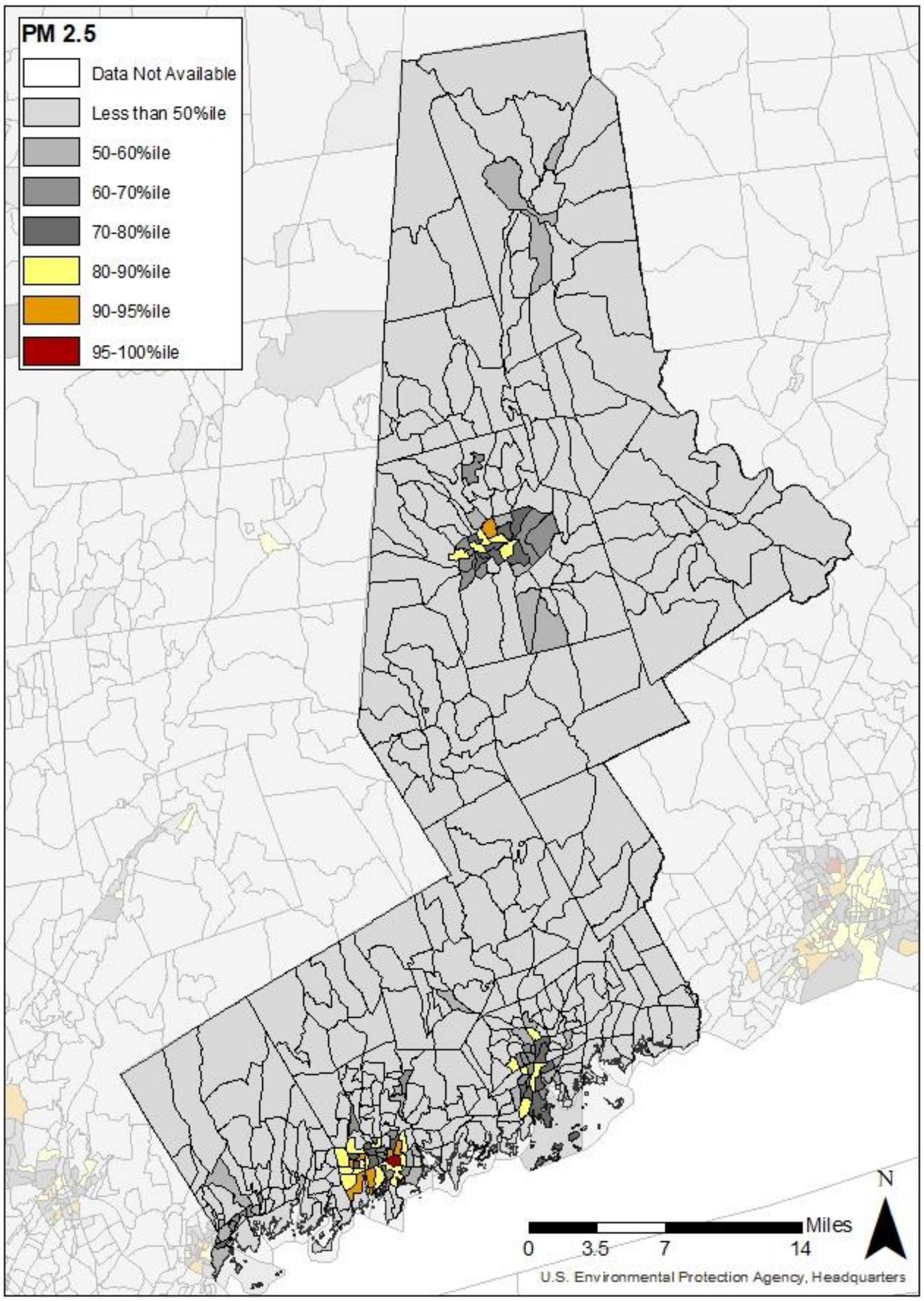
Map 4: Traffic Proximity in Western Connecticut



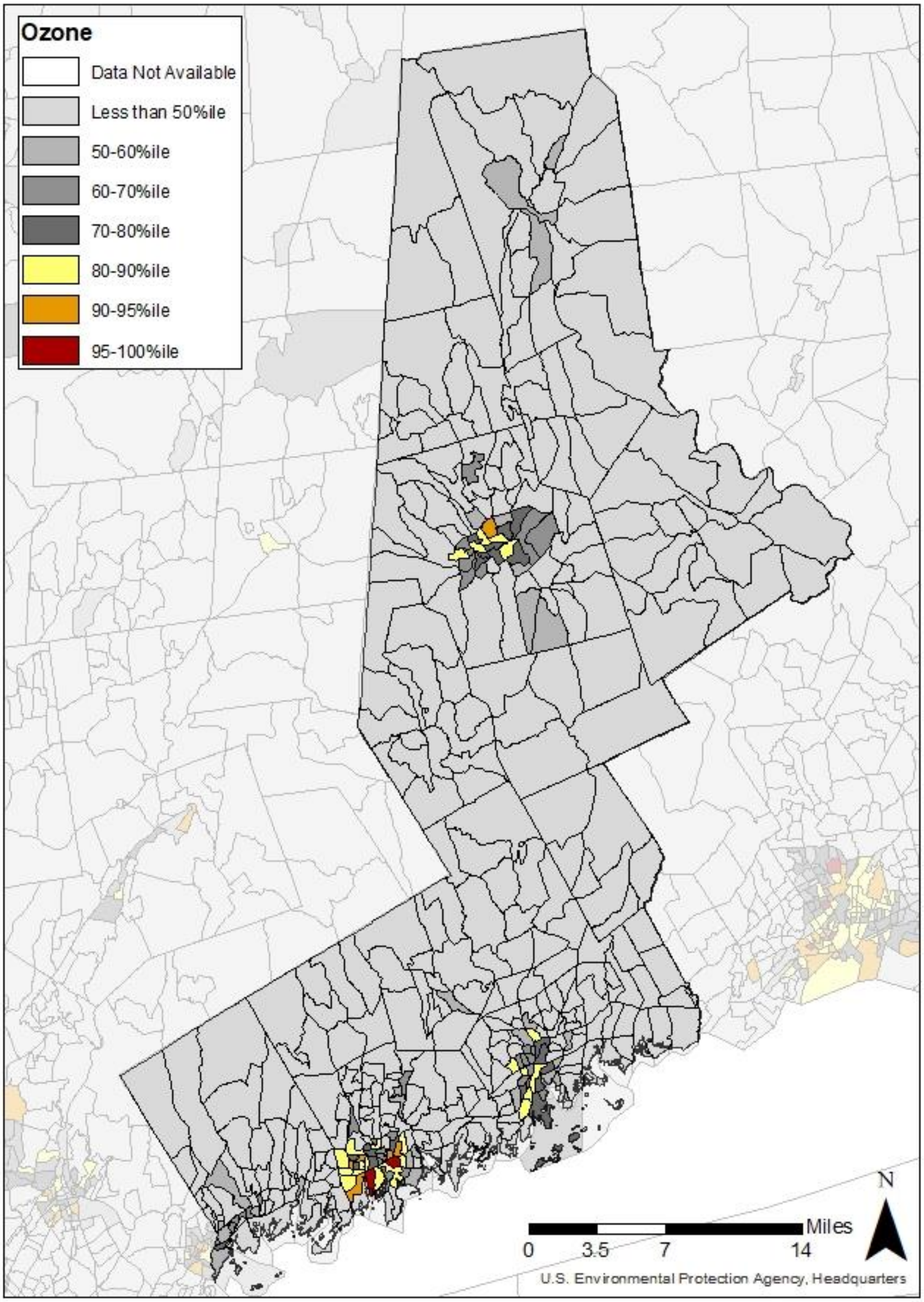
Particulate Matter & Ozone

Traffic, industry, and other sources can contribute to elevated levels of particulate matter and ozone in the air. These compounds exacerbate respiratory health conditions like asthma, and are key factors in warming and smog. Maps 5 and 6 display areas of high particulate matter and ozone compared to other areas in the United States. Urban areas in the Region are within the highest national percentiles. These areas have the highest annual average of PM 2.5 in the air, and highest summer seasonal average level of ozone in parts per billion.

Map 5: Particulate Matter in Western Connecticut



Map 6: Ozone in Western Connecticut



Analysis of the Current Canopy

Analyzing the current canopy establishes a baseline and facilitates the creation of goals.

Benefits

Trees have proven their utility through the abundance of benefits they provide. These benefits can be quantified into monetary values to better understand the economic impact of planting trees. By removing compounds and particulates from the atmosphere, trees can save municipalities thousands of dollars a year. Trees also add to property value, manage stormwater, sequester carbon over their lifetimes.

Using the Northeast Community Tree Guide, WestCOG estimated the benefits that the trees in Norwalk provide. On average over their lifespans, trees produce between $30 and $147 in benefits per year depending on their size. These figures include energy savings, stormwater runoff reduction, aesthetic value, air quality improvement, and carbon dioxide sequestration. Each year, Norwalk's trees provide nearly $1.3 billion in benefits. This equates to $2,104.27 per resident annually.

Table 2: Current Benefits of Tree Canopy in Western Connecticut

Tree Size	Number of Trees	Annual Benefits	Benefits per Capita
Small	155,774	$4,673,220	$7.79
Medium	9,462,764	$747,558,356	$1,245.76
Large	3,472,769	$510,497,043	$850.71
Total	**13,091,307**	**$1,262,728,619**	**$2,104.27**

Costs

Estimates from McPherson et al (2007) find that on average a small, medium, and large public tree needs $20, $27, and $34 worth of care per year over their lifetimes. This includes planting, pruning, other maintenance, and infrastructure repair.

In Western Connecticut, this equates to $376.6 million per year. However, it should be noted that not all trees in the Region are intentionally planted or receive maintenance so this estimate may be higher than actual costs.

Table 3: Current Costs of Tree Canopy in Western Connecticut

Tree Size	Number of Trees	Annual Costs	Costs Per Capita
Small	155,774	$3,115,480	$5.19
Medium	9,462,764	$255,494,628	$425.77
Large	3,472,769	$118,074,146	$196.76
Total	**13,091,307**	**$376,684,254**	**$627.72**

Net Analysis

The net benefits of Norwalk's tree canopy are estimated to be $886 million annually. Per resident it provides $1,476.54 in net benefits per year.

Using the estimates previously detailed, WestCOG found that for every dollar spent on tree care, the Region receives $3 in benefits.

Table 4: Net Analysis of Trees in Norwalk

	Annual Value
Benefits	$1,262,728,619
Costs	$376,684,254
Net Benefits	**$886,044,365**
Ratio	**3:1**

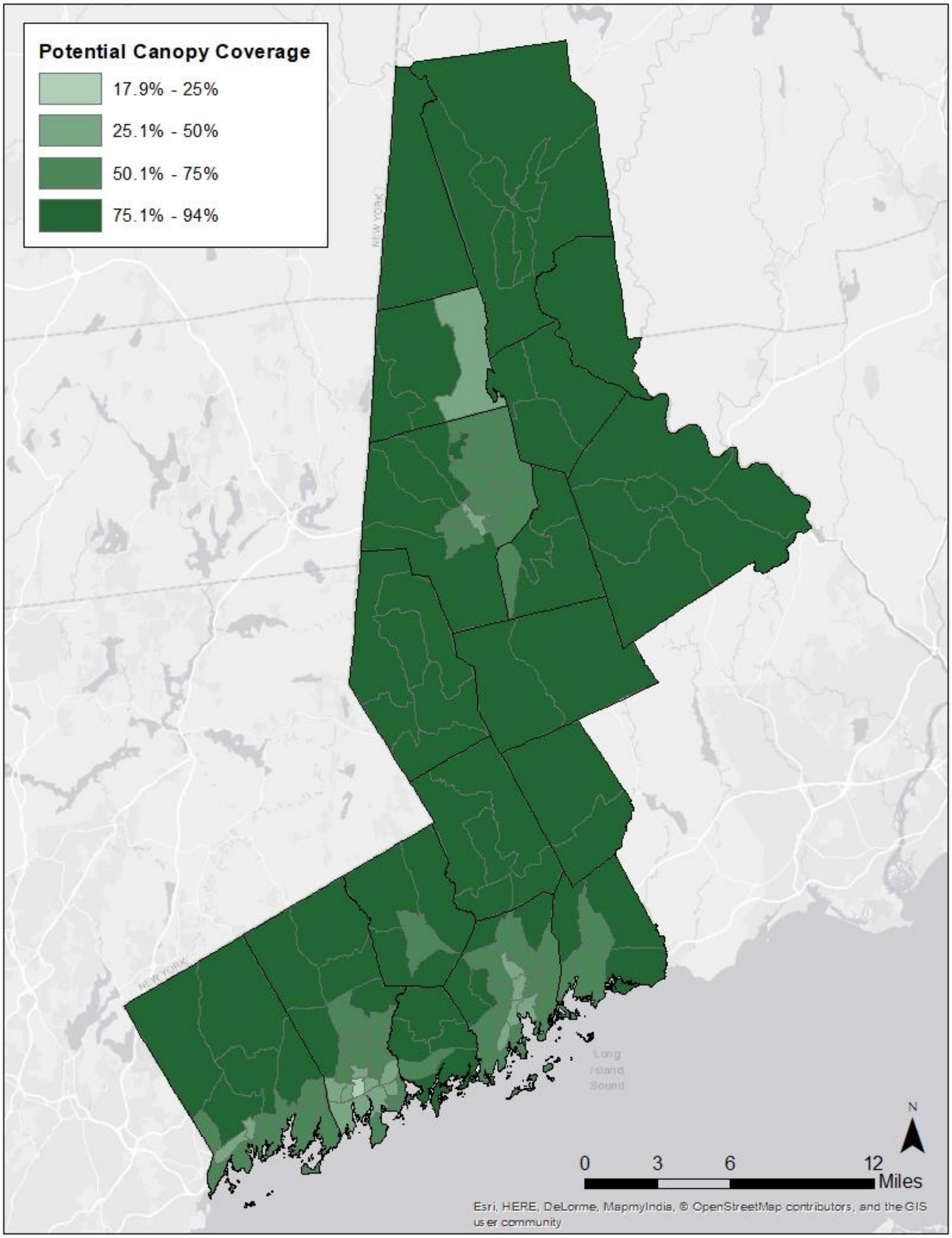
Potential for Increased Canopy

To estimate how much land could be planted to contribute to the tree canopy, the amount of available land must be identified. The table below show how much land in each municipality is not impervious surface, water, and within 30 feet of a telephone pole and compares it to current canopy. This illustrates the potential for increasing canopy in each municipality without "unbuilding" current structures. New Milford, Greenwich, Danbury, Newtown, Stamford, and Norwalk have the largest discrepancies in acreage between their current canopy and the available land for planting. Greenwich, Darien, Westport, New Milford, Norwalk, and Bridgewater could see the largest proportional increase in canopy if they were to plant out to their potential.

Table 3: Potential Tree Canopy in Western Connecticut

	Total Acres	Potential Canopy Acres	Current Canopy Acres	Difference in Acres	Current Canopy (%)	Potential Canopy (%)	Difference (%)
Greenwich	31,089	24,025	15,351	8,674	49.4%	77.3%	27.9%
Darien	8,140	6,096	3,879	2,217	47.6%	74.9%	27.2%
Westport	12,917	9,360	6,083	3,278	47.1%	72.5%	25.4%
New Milford	40,882	35,575	25,636	9,939	62.7%	87.0%	24.3%
Norwalk	14,754	9,236	5,780	3,456	39.2%	62.6%	23.4%
Bridgewater	11,110	9,968	7,573	2,395	68.2%	89.7%	21.6%
Brookfield	13,037	10,483	7,762	2,721	59.5%	80.4%	20.9%
New Canaan	14,424	11,578	8,729	2,848	60.5%	80.3%	19.7%
Danbury	28,118	19,827	14,627	5,200	52.0%	70.5%	18.5%
Stamford	24,591	16,726	12,333	4,393	50.2%	68.0%	17.9%
Bethel	10,844	8,781	6,918	1,864	63.8%	81.0%	17.2%
Sherman	14,971	12,914	10,661	2,253	71.2%	86.3%	15.1%
Newtown	37,697	31,965	26,911	5,055	71.4%	84.8%	13.4%
Wilton	17,498	14,385	12,382	2,003	70.8%	82.2%	11.4%
New Fairfield	16,103	11,494	9,665	1,829	60.0%	71.4%	11.4%
Ridgefield	22,310	17,734	15,291	2,443	68.5%	79.5%	11.0%
Redding	20,496	18,112	16,054	2,058	78.3%	88.4%	10.0%
Weston	13,225	10,718	9,889	830	74.8%	81.0%	6.3%
WestCOG	**352,206**	**278,978**	**215,521**	**63,457**	**61.2%**	**79.2%**	**18.0%**

Map 7: Maximum Potential Canopy Coverage in Western Connecticut



Street Tree Potential

The likely culprit for decreased canopy in city and town centers is an increase of impervious surface (i.e. roads, buildings, and parking lots). Impervious surface is also responsible for much of the negative environmental externalities of urban living such as stormwater runoff and urban heat island effect. When planted near impervious surfaces, tree can mitigate some of these negative impacts by absorbing water and slowing rain flow, as well as shading surfaces and cooling them. Street trees can also make these areas more attractive places to residents and visitors.

Planting trees along streets could provide the largest return on investment. Danbury, Greenwich, New Milford, Stamford, Newtown, and Norwalk can gain the most acreage in their tree canopy from planting along available space. Norwalk (5.67%), Westport (4.52%), Danbury (4.15%) Darien (4.07%), Brookfield (3.75%), and Stamford (3.70%) would see the largest percent increases. If trees covered all available street tree space, the Region would gain nearly 10,000 acres of canopy, an increase of almost 3%.

Street Tree Potential was calculated by creating a 50-foot buffer along of the streets in the Region, then subtracting impervious surface, existing canopy, and telephone poles with a 30-foot buffer around them. These estimates are assumed to be high because topology, soil type, sightlines, and other factors play a role in an area's suitability for tree planting.

In urban settings, trees tend be planted closer together, have more competition, and smaller species are selected. Literature on this subject indicates that in urban/ street tree scenarios there can be an estimated 34.7 trees per acre. This figure was used to estimate the potential number of trees within the plantable area.

Table 4: Maximum Street Tree Potential in Western Connecticut

	Potential Additional Street Tree Acres	Percent of Total Acres	Estimated Potential Number of Trees
Danbury	1,168.0	4.15%	161,950
Greenwich	1,114.8	3.59%	154,573
New Milford	1,010.0	2.47%	140,042
Stamford	910.9	3.70%	126,302
Newtown	861.4	2.29%	119,438
Norwalk	836.2	5.67%	115,944
Westport	584.0	4.52%	80,975
Ridgefield	571.2	2.56%	79,200
Brookfield	488.5	3.75%	67,733
New Fairfield	342.4	2.13%	47,476
Bethel	335.2	3.09%	46,477
Darien	331.1	4.07%	45,909
New Canaan	320.1	2.22%	44,384

Wilton	286.3	1.64%	39,697
Redding	262.6	1.28%	36,411
Sherman	205.1	1.37%	28,438
Weston	196.2	1.48%	27,204
Bridgewater	124.4	1.12%	17,249
WestCOG	**9,948.4**	**2.82%**	**1,379,403**

Benefits of Increased Canopy

The Western Connecticut Region enjoys millions of dollars in savings annually from its current tree canopy. It is in the Region's interest to populate available land with trees to thicken and expand the canopy. The tables below calculate the "plantable" land that could be used to increase canopy and how increasing canopy on this land would positively impact the Region.

If the Region were to plants trees on every bit of land that did not have impervious surface or current canopy, or was within 30 feet of a telephone pole, the Region could increase its canopy to a total of 352,260 acres and cover 79.2% of the Region. This analysis acknowledges that canopy can extend over the plantable area, and plantable area can be made on top of impervious surface such as in the case of a roof garden, however we thought it best to take a more conservative estimate. This increase in canopy would in turn increase the annual benefits the canopy would provide to $77,116,584.40. This figure does not include the estimated $1,240,666,470.30 benefits the trees would provide in Carbon storage.

Table 5: Potential Benefits of Maximum Canopy in Western Connecticut

Benefit Type (Annual)	Estimates	Per Capita Benefits
Carbon Monoxide (CO)	$198,026.60	$0.33
Nitrogen Monoxide (NO_2)	$312,675.70	$0.52
Ozone (O_3)	1,637,964.50	$2.73
Particulate Matter < 2.5 microns (PM2.5)	5,061,903.80	$8.44
Sulfur Dioxide (SO_2)	$21,319,120.50	$35.53
Particulate Matter 10 < 2.5 microns (PM10*)	$27,81.10	$0.01
CO_2 sequestered in trees	$38,559,076.10	$64.26
Total each year	$77,116,584.40	$128.51
CO_2 stored in trees (not annual)	$1,240,666,470.30	$2,067.50

Of the total potential acres, 9,948.4 acres would be considered for street trees, within 50 feet of the road centerline. If the Region were to solely increase canopy in this plantable area, canopy coverage would increase to 64%. This would increase annual benefits from trees by $2,749,989.71, totaling to $62,329,430.88. It would also increase the benefits of stored Carbon in trees to $1,002,767,895.27.

Table 6: Potential Benefits of Maximum Street Trees Canopy in Western Connecticut

Benefit Type (Annual)	Estimates	Per Capita Benefits
Carbon Monoxide (CO)	$160,054.86	$0.27
Nitrogen Monoxide (NO_2)	$252,719.97	$0.42
Ozone (O_3)	$9,406,377.51	$15.68
Particulate Matter < 2.5 microns (PM2.5)	$4,091,280.57	$6.82
Sulfur Dioxide (SO_2)	$17,231,165.73	$28.72
Particulate Matter 10 < 2.5 microns (PM10*)	$22,483.19	$0.04
CO_2 sequestered in trees	$31,165,349.05	$51.94
Total each year	$62,329,430.88	$103.87
CO_2 stored in trees (not annual)	$1,002,767,895.27	$1,671.06

Infrastructure Repair

Studies of other US cities found that the average annual cost to repair sidewalks from tree damage is $3.01 per tree, and average annual to repair curb and gutter damage is $1.14 per tree (Randup et al, 2001). However, many of the trees in the Region are not in urban areas and would not interact with infrastructure. Thus, it makes to use the low end of the estimated tree range to calculate cost estimates. Trees in the Region cause an estimated $22,488,697.28 in sidewalk repairs and an estimated $8,517,313.92 in curb and gutter repairs annually. These repairs total $31,006,011.20 per year.

Conclusion

Trees are essential to health and vibrancy of the Region. They provide a host of valuable economic, social, and environmental benefits. These benefits include cleaner air and water, lower stormwater infrastructure costs, lower summer temperatures and lower cooling costs, higher property values and higher business revenues, and better physical and mental health. However, these benefits are often underappreciated or ignored. The failure to consider the benefits of trees fully has led to the neglect and subsequent decline of trees, especially in urban areas. Unfortunately, the savings obtained through neglect and loss of trees pales in comparison to the benefits that those trees would have produced.

This report quantified both existing and potential tree canopy cover in Norwalk. It estimated both the costs and the benefits trees currently do and could provide the Region. The current tree canopy provides an estimated $1.3 billion in benefits annually, at a cost of $376.7 million annually.

This analysis demonstrates that tree planting is economically feasible and, indeed, will generate far more value than it demands in municipal resources.

Trees are a long-term investment, creating value as they grow. In return for the time, effort, and funds required for planting and care, trees will contribute to a healthier, more vibrant community for years to come.

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Appendix A: Tree Guidance

Recommended Trees

The following lists were compiled using the University of Connecticut's Plant Database. The recommendations are listed by size and separated by suggested location based on tolerance to salt and sea spray. Planting areas south of US Route 1 may be more susceptible to ocean flooding and sea level rise over time and should be planted with trees that can accommodate increases in salinity. Tree listed in the salt tolerant list are also recommended for planting north of Route 1. All trees listed are native to Connecticut, hardy to Zone 6, and tolerant of urban environments so they may be used both as street trees and lawn trees. Native trees may require less maintenance and replacement, they also provide more ecosystem services to native animal species. This list does not restrict municipalities or property owners from planting other species of trees.

CT Native, Hardy to Zone 6, Urban Tolerant, Salt/Sea Spray Tolerant (South of Route 1)

Tree 80′ +

1. Acer saccharinum, Silver Maple
2. Fraxinus Americana, White Ash
3. Quercus rubra, Red Oak, Northern Red Oak

Tree 50′ – 80′

1. Fraxinus pennsylvanica, Green Ash, Red Ash
2. Juniperus virginiana, Eastern Redcedar
3. Liquidambar styraciflua, American Sweetgum
4. Nyssa sylvatica, Black Tupelo, Black Gum

Tree 30′ - 50′

1. Acer negundo, Boxelder, Ash-leaved Maple
2. Celtis occidentalis, Common Hackberry

Tree 15′ – 30′

1. Crataegus crusgalli, Cockspur Hawthorn
2. Juniperus communis, Common Juniper
3. Rhus glabra, Smooth Sumac
4. Rhus typhina, Staghorn Sumac
5. Salix discolor, True Pussy Willow

Shrub 8′+

1. Amelanchier canadensis, Shadblow Serviceberry, Thicket Serviceberry
2. Myrica pensylvanica, Northern Bayberry, Candleberry

Shrub 4′ -8′

1. Clethra alnifolia, Summersweet, Sweet Pepperbush

Shrub < 4′

1. Juniperus horizontalis, Creeping Juniper
2. Potentilla fruticose, Bush Cinquefoil

Other

1. Arctostaphylos uva-ursi, Bearberry, Kinnikinick
2. Parthenocissus quinquefolia, Virginia Creeper, Woodbine

CT Native, Hardy to Zone 6, Urban Tolerant, Not previously listed (North of Route 1)

Tree 50' – 80'

1. Acer rubrum, Red Maple, Swamp Maple
2. Betula nigra, River Birch
3. Quercus macrocarpa, Bur Oak, Mossycup Oak
4. Quercus palustris, Pin Oak, Swamp Oak
5. Quercus prinus, Chestnut Oak, Basket Oak
6. Tilia Americana, American Linden, Basswood

Tree 30' - 50'

1. Acer negundo, Boxelder, Ash-leaved Maple
2. Ostrya virginiana, American Hophornbeam, Ironwood
3. Quercus bicolor, Swamp White Oak

Tree 15' - 30'

1. Amelanchier arborea, Downy Serviceberry, Shadbush
2. Amelanchier canadensis, Shadblow Serviceberry, Thicket Serviceberry
3. Crataegus mollis, Downy Hawthorn
4. Juniperus horizontalis, Creeping Juniper
5. Rhus copallina, Flameleaf Sumac, Shining Sumac
6. Viburnum prunifolium, Blackhaw Viburnum

Shrub 8'+

1. Cornus racemose, Gray Dogwood
2. Cornus sericea, Redosier Dogwood
3. Myrica pensylvanica, Northern Bayberry, Candleberry
4. Physocarpus opulifolius, Common Ninebark, Eastern Ninebark

Shrub 4' - 8'

1. Aronia arbutifolia, Red Chokeberry
2. Comptonia peregrine, Sweetfern
3. Ilex glabra, Inkberry
4. Rhus aromatic, Fragrant Sumac

Shrub < 4'

1. Aronia melanocarpa, Black Chokeberry
2. Potentilla fruticose, Bush Cinquefoil

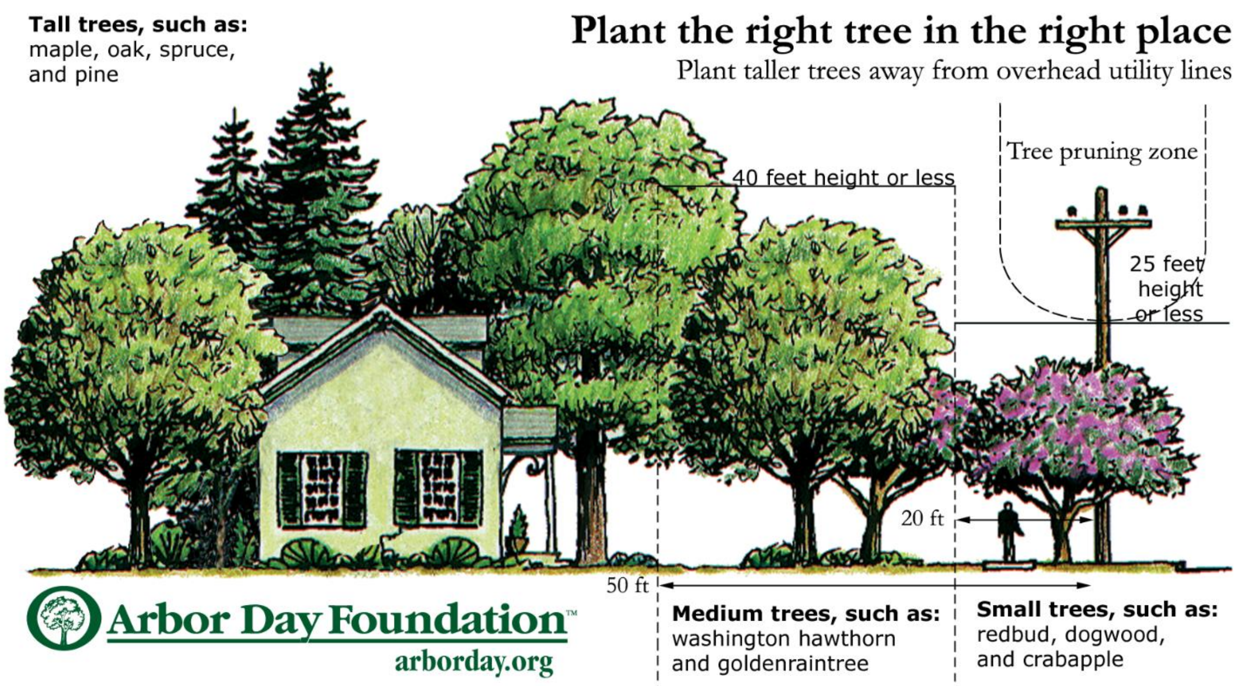
Viburnum prunifolium, Blackhaw Viburnum
Source: David Stang, 2006, commons.wikimedia.org

Right Tree, Right Place

Adding trees to a property can increase home value and reduce energy cost. When selecting trees for planting, it is important to take into account not only the requirements the tree will need to thrive, (soil, sun, moisture, and climate) but also the landscape around the planting site and the tree species. While the full size of the tree may not be apparent for several seasons, trees can create conflicts due to their height and canopy spread as they grow. Well intentioned trees can damage utility lines, roofs, and infrastructure like sidewalks and sewer drains if not properly sited. These conflicts are easily avoided if the right species tree is selected for the right place.

Eversource Tree Planting Guidance

Eversource has put together a list of recommended native species for plantings that have appropriate tree heights but are also aesthetically pleasing. The program is called "Plan before you Plant" and a handout of recommended species are provided, the planting list can be found here: https://www.eversource.com/content/ct-c/residential/outages/avoiding-an-outage/tree-trimming/plan-before-you-plant



Tree Maintenance

Pruning

Each year thousands of trees are killed by homeowners and non-professional landscapers who try to prune a tree without knowledge of what keeps a tree alive, healthy, and beneficial to the environment. A licensed arborist is your best choice for pruning a tree.

Trees need to be pruned correctly. If not, this damage can be compounded as the tree struggles to stay alive. In many cases, it may take years before a tree dies from incorrect pruning. Cutting a tree is not like trimming and designing a hedge. One cannot just cut it to the desired height and shape, regardless of the height and spread the tree needs to survive. Incorrect pruning shortens the life of the tree by disfiguring the natural form, causing wounds that the tree cannot heal, and creating sites for infection and invasion for fungus, pests, and pathogens.

How to Correctly Prune a Tree

Allow a tree to grow as much as possible naturally. However, when trimming is necessary, there are proper guidelines to manage the growth and not cause death and disease to the tree.

1. Make a small wedge-shaped cut on the underside of the branch, on the branch side of the stem collar. This will break the bark and prevent a tear along the bark.
2. Farther along the branch, starting at the top, cut all the way through the branch, leaving a stub end.
3. Finally, make a third cut parallel to and just on the branch side of the stem collar to reduce the stub length.

Tree Benefits from Pruning

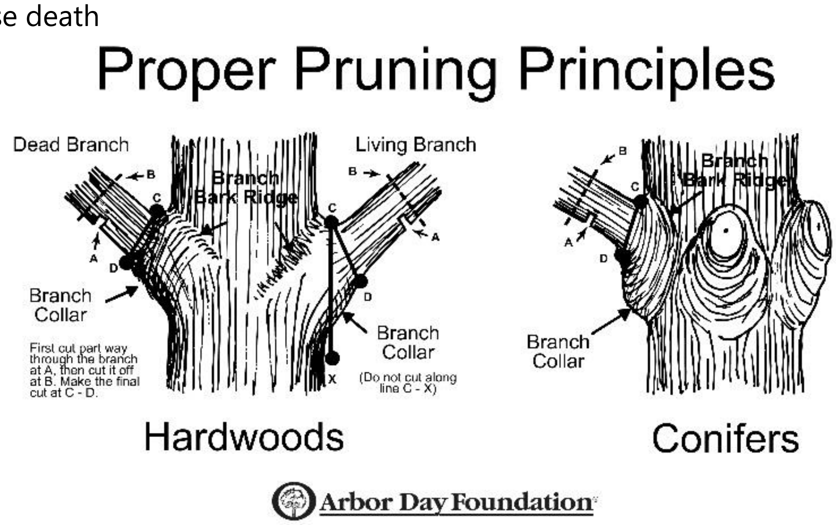
After pruning, new foliage is fresh and vibrant. The tree has new vigor as the nutrients flood into the remaining branches. Young tree pruning strengthens the growth and flowering ability of the plant. The best time to remove low-lying branches, disproportionate trunk or limbs; is when they are young.

Season to Prune

The dormant season, late fall or winter, is the best time to prune. Although dead branches can be removed anytime. Pruning during the dormant period minimizes sap loss, and reduces the risk of insect invasion and fungus infection.

How Much to Prune

Prune as little as possible. No more than 10% - 15% of the crown should be removed, and it is best to ensure that the living branches compose at least 2/3 of the height of the tree.



Mulching

Wood mulch can be an excellent tool to etain moisture and suppress weeds around the trunk of a tree. However, improper mulching can have negative impacts on tree health. If mulch is piled too high around a tree trunk, it smothers the roots and trunk. The moisture it retains can cause rot and become a home for fungus. Borrowing insects are also attracted to deep mulch piles and may harm the tree.

Tips for mulching

- Never build a "mulch volcano" around a tree trunk.
- Keep mulch away from the tree trunk.
- The mulch should be no more than 3 inches deep.

Improper Mulch
Root flare buried &
Mulch piled high up against the trunk

Proper Mulch
Root flare visible at the base of the tree &
Mulch extends to dripline of canopy

Source: treefolks.org