

# The Urban Tree Canopy: An Opportunity for Sustainable Development

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## Abstract

A healthy urban tree canopy provides ecological services, impacts humans' quality of life, and generates economic benefits. As the urban tree canopy is degraded and removed, the loss of these benefits often translates into environmental, human-health, and economic costs. In Asheville, North Carolina, development is a double-edged sword—construction of new residential housing is required to support the city's growing population, however, this construction usually requires removal of trees and their associated natural ecosystems. Qualitative data was collected, through surveys and interviews, surrounding how Asheville residents perceive and value the urban tree canopy. Most survey and interview participants greatly value Asheville's urban trees and are concerned about these trees in the face of development. Sustainable development presents a great opportunity to allow both development and preservation of trees to occur in a way that equally values the local environment, people, and economy. Opportunities to protect and support the urban tree canopy are provided as a call to action for individuals, community groups, private businesses, and local government.

## 1. Introduction

The urban tree canopy is a key feature in the broader discussion of open space and greenspace in urban areas. Open space is defined as any land that is "undeveloped" (meaning, there are no structures built by humans on it), while greenspace refers specifically to undeveloped land that is partially or completely covered with vegetation, such as grass, shrubs, and trees.<sup>1</sup> The term "urban tree canopy," used interchangeably with "urban forest," refers specifically to the trees that are found in an urban setting.<sup>2</sup> Urban tree canopies provide many benefits to local ecosystems, human residents and visitors, and the local economy.

Urban forests provide green (as opposed to anthropogenic) infrastructure and processes which are important to the local ecosystems. Urban forests provide refuge for wildlife, which may be scarce in urbanized areas. A case study conducted by MacGregor-Fors et al. found that larger greenspaces with little human activity were associated with the highest species richness values.<sup>3</sup> While soil health is unique to each location, urban soil restoration that includes tree-planting tends to have positive impacts on the soil microbiome, water retention capacity, carbon and nitrogen content, and soil pH.<sup>4</sup> Improved soil health also contributes to an urban forest's ability to retain water and remove pollutants from runoff.<sup>5</sup> Similarly, urban forests remove pollutants from the air, which improves air quality.<sup>6</sup> Urban trees help to regulate temperatures through both shading and evapotranspiration.<sup>7</sup>

Many benefits of urban trees also impact humans. Many people, especially in urban areas, appreciate the shade and cooling properties provided by trees in warmer climates, both for physical comfort and lessening heat-related health concerns (such as heat stroke).<sup>7,8</sup> Humans in areas with many trees may also experience improved respiratory health due to cleaner air.<sup>6,8</sup> Although each neighborhood is unique, some research shows that people who live in more vegetated areas are more likely to be physically active and, therefore, in better overall health.<sup>8,9</sup> Similarly, urban greenspaces featuring edible landscaping, such as community gardens, may contribute to healthier lifestyles of people living nearby due to the accessibility of fresh produce.<sup>8</sup> Greenspaces can act as restorative environments to relieve stress, reduce pain, improve well-being, and aid those recovering from surgery or illness.<sup>10,11</sup> Regular access to

greenspaces provides other psychological benefits such as improved cognitive function, which may enhance performance at school and work.<sup>8</sup> There is a growing field of research showing that natural spaces may be used to treat conditions such as Attention Deficit/Hyperactivity Disorder,<sup>12</sup> Major Depressive Disorder,<sup>13</sup> and Dementia.<sup>14</sup>

Some benefits of urban forests can also be translated into economic benefits. A healthy urban forest may help to reduce healthcare and infrastructural costs. For example, trees' natural ability to remove air pollutants results in better air quality and improved human health and, therefore, less money required to address air quality and air-pollution-related health concerns.<sup>6</sup> Mature urban trees may help retain and manage rainwater, thus decreasing, and potentially eliminating, the need to designate funding for stormwater management infrastructure.<sup>5,15</sup> If strategically placed, trees may reduce energy required to cool buildings in warmer climates, due to their cooling and shading properties, which may lead to financial savings.<sup>16</sup> In addition to cost savings, greenspace and vegetation may help to increase revenue of the local economy. Trees may increase property value, as many homeowners greatly value trees on their lots and within their neighborhoods.<sup>17</sup> A study conducted in Florida found that property values, on average, increased by \$1,586 per tree.<sup>18</sup> Urban trees within commercial areas may encourage consumers to spend more time walking around and purchasing the goods and services of businesses in that area.<sup>19</sup> Due to humans' natural inclination to the beauty of greenery, urban forests are especially appealing to tourists and may even complement other tourist activities, such as historic sites and tours.<sup>20</sup>

Anthropogenic activities, especially urbanization and development, threaten ecosystem health and integrity. Humans cause direct disturbance to ecosystems via construction, intensive use, modification and fragmentation of habitats, pollution (including heavy metals, fuel, and trash), spreading of exotic invasive species, and feeding of wildlife.<sup>21,22</sup> Humans also indirectly impact urban ecosystems through noise pollution, light pollution, air pollution, altering temperatures, and interrupting ecosystem productivity.<sup>21,22</sup>

The mismanagement, or lack of management, of urban ecosystems in the wake of urbanization often results in environmental degradation, which also affects humans and the economy. Urbanization reduces biodiversity for most biotic communities (with the exception of birds), especially if humans remove native plants and replace them with monocultures (i.e. grass lawns) and exotic-invasive plants (usually contributing to the endangerment of native species).<sup>21</sup> Biodiversity reduction and ecosystem disruption inhibit the ecosystem's ability to support its human and nonhuman inhabitants.<sup>21</sup> If people do not live and work near trees and greenspaces, they are unable to reap the physical, psychological, and economic benefits discussed previously. Soil that has been compacted and is in poor health not only endangers ecological communities, but also worsens the city's stormwater management problems by increasing likelihood of both drought and flooding—which can be expensive to address.<sup>21</sup> Replacement of vegetation with impervious surfaces contributes to a phenomenon known as the urban heat island effect, which is characterized by warmer temperatures within urban areas, relative to surrounding non-urban areas.<sup>23</sup> The urban heat island effect alters ecosystem function and dynamics in many ways, including disrupting plant phenology patterns such as leaf-out, flowering, fruiting, and leaf shedding.<sup>24</sup> The urban heat island effect also has negative impacts on humans. Higher temperatures alone may intensify health problems and so can heightened emissions from increased energy usage to cool buildings.<sup>25</sup> Increased energy usage, air pollutant concentrations, and respiratory health concerns may be accompanied by increased financial costs.<sup>25</sup> If a city does not have sufficient tree cover and greenspaces, the local economy may be missing out on opportunities to increase property values, attract tourists, and bring in more revenue. While each city and its ecology is unique, it is important to consider whether it would be more socially and economically favorable to maintain and cultivate urban forests or replace them with anthropogenic infrastructure.

The urban tree canopy of Asheville, North Carolina, is shrinking and development is one of the major threats to urban trees.<sup>26</sup> Some Asheville residents are already experiencing the impacts of urban tree removal; if our remaining urban forests continue to be replaced with buildings and pavement, these negative impacts will intensify. To preserve Asheville's urban tree canopy, city decision-makers should recognize the significance of urban trees to residents and identify opportunities for sustainable management of urban trees while meeting the city's need for housing.

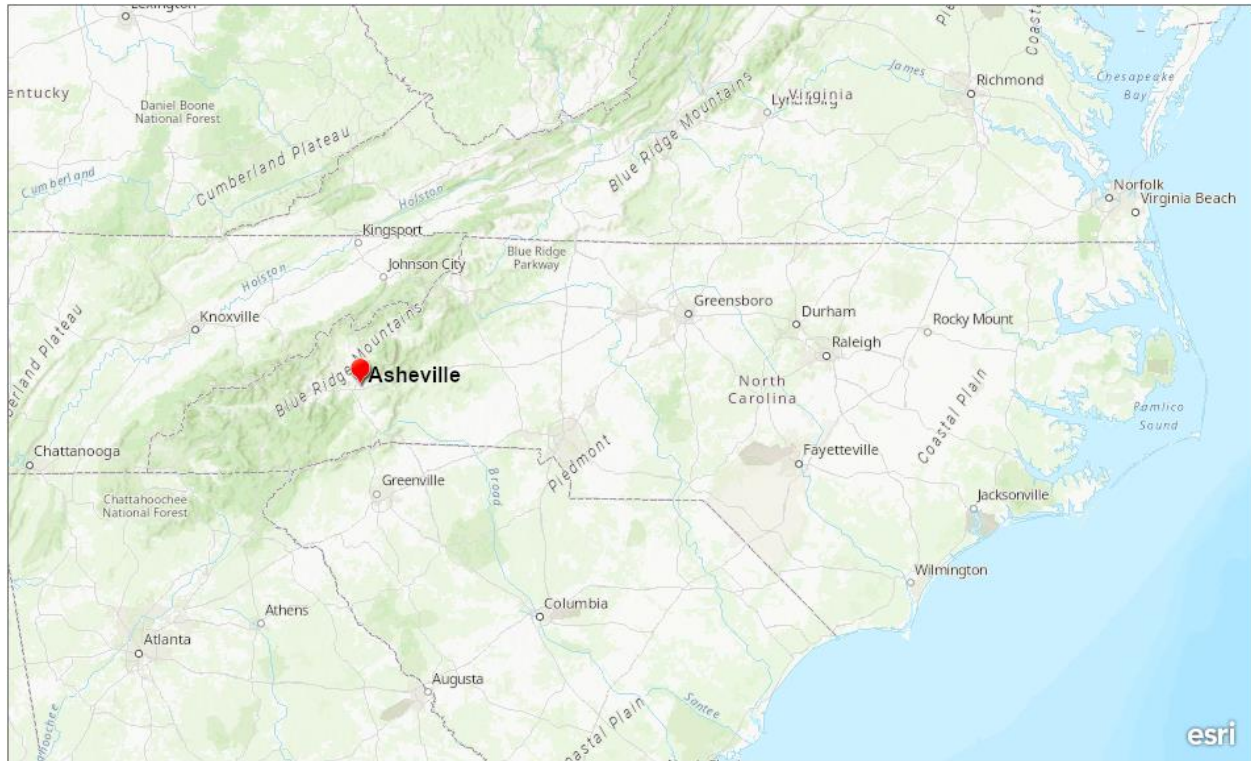
## 2. Methods

The following questions guide this research: What are the benefits associated with urban tree cover, in general, and specifically in Asheville, North Carolina? What are the costs associated with lack of urban tree cover in general, and specifically in Asheville, NC? How do the residents of Asheville, NC, perceive and value the urban tree canopy? How might these experiences differ between neighborhoods?

## 2.1 Study Site Descriptions

### 2.1.1 city of asheville

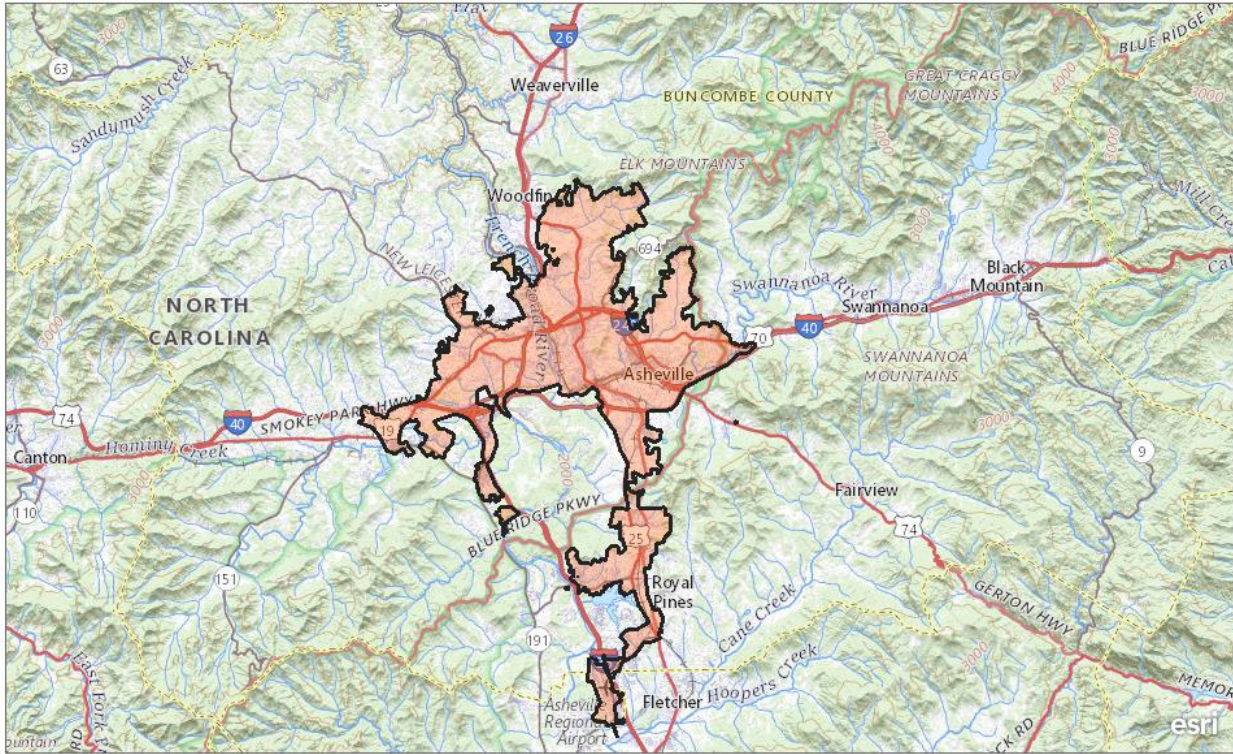
Asheville is located in western North Carolina, among the Blue Ridge Mountains (Figure 1). Throughout this paper, the term “Asheville” specifically refers to the land that has been incorporated into “the City of Asheville” (see Figure 2). According to 2020 census data, Asheville’s population saw an increase of 13% from 2010 to 2020, with a population of around 94,500 as of 2020.<sup>27</sup> Roughly 64% of the Asheville population (16 years and older) is in the civilian labor force.<sup>27</sup> The median household income is just over \$50,000 and over 12,000 people (13% of the population) are impoverished.<sup>27</sup> Asheville’s tourism sector brings in almost 10 million visitors and around \$2 billion yearly.<sup>28</sup> The Asheville area’s growing population requires an increase in housing developments. In January 2022, 338 new residential building permits were granted in the Asheville Metro Area (comprised of Buncombe, Haywood, Henderson, and Madison counties), amounting to \$78.7 million (13.7% increasing from January 2021).<sup>29</sup>



Esri, USGS | Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS

Figure 1. Asheville in the state of North Carolina

Figure 1. The City of Asheville is located in western North Carolina among the Blue Ridge Mountains. *Figure created by Ally Fouts using map layers from listed sources on [arcgis.com](https://arcgis.com).*



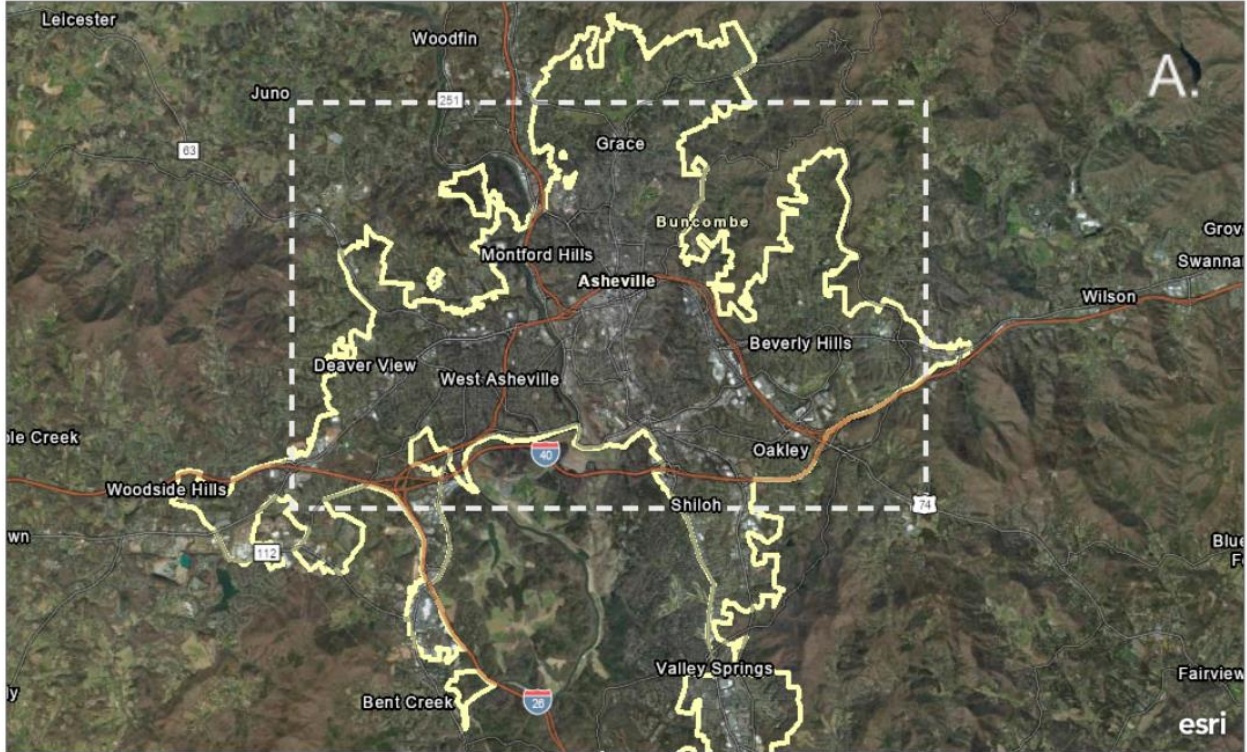
This data describes the City of Asheville jurisdictional boundaries.

USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

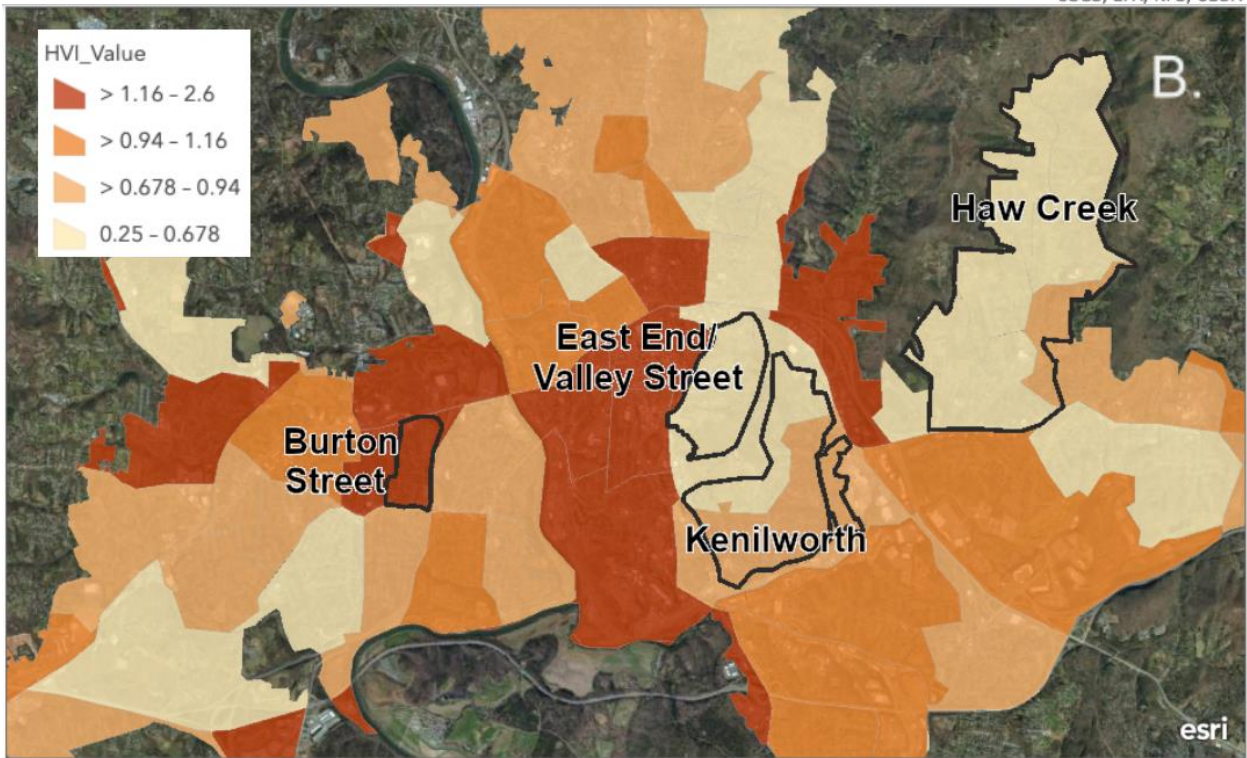
Figure 2. The City of Asheville, North Carolina

Figure 2. The City of Asheville is located in Buncombe County, at the intersection of I-40 (running east to west) and I-26 (running north to south). *Figure created by Ally Fouts using map layers from listed sources on [arcgis.com](https://arcgis.com).*

This study focused on four neighborhoods in Asheville: Burton Street, East End/Valley Street, Haw Creek, and Kenilworth. Figure 3 shows where these four neighborhoods are located, layered over a map demonstrating urban heat island vulnerability.<sup>30</sup> To create this map, Gray et al. assigned a heat vulnerability index (HVI) value to each census block group by compiling three factors: socioeconomic vulnerability (poverty level and age), land surface temperatures, and percentage tree canopy cover.<sup>31</sup> Areas with a higher HVI value, illustrated by the darker red color on the map, are the most vulnerable to the urban heat island effect, while the areas with the lowest HVI values, illustrated by lightest yellow color, are the least vulnerable to the urban heat island effect. The four neighborhoods chosen to study have varying HVI values, as demonstrated by Figure 3.



NC CGIA, Earthstar Geographics | Buncombe County, NC, State of North Carolina DOT, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA



This map contains the urban heat vulnerability index created by NASA DEVELOP in fall 2019. Click on part of the city to find explanations of the index for that area.

NC CGIA, Earthstar Geographics

**Figure 3. Asheville Locator Map and Heat Vulnerability Map**

**Figure 3. Figure 3a is a locator map showing the area of Asheville shown in Figure 3b. Figure 3b** portrays the heat vulnerability map for Asheville created by Gray et al. These NASA DEVELOP researchers compiled socioeconomic status (poverty level and age), land surface temperatures, and tree canopy cover to determine a heat vulnerability index (HVI) value to each census block group in the City of Asheville. Higher HVI values indicate the most vulnerable areas, which are represented by darker red on the map. Lower HVI values indicate the least vulnerable areas, represented on the map by lighter yellow. Burton Street, East End/Valley Street, Haw Creek, and Kenilworth are also indicated on this map. These four neighborhoods were chosen for the present study predominantly due to their varying levels of vulnerability to the heat island effect. *Figure created by Ally Fouts using map layers from listed sources on [arcgis.com](http://arcgis.com).*

### *2.1.2 burton street*

The Burton Street Community, located in West Asheville (Figure 2), is a historically black community founded in 1912 by E.W. Pearson.<sup>31</sup> The mostly wooded landscape, Smith Mill Creek running alongside the neighborhood, and home farms/gardens have been valued by Burton Street Community members since the neighborhood was founded.<sup>32</sup> The neighborhood began losing land and trees in the late 1950s when Patton Avenue was widened. In the 1960s, the construction of Interstate 240 (I-240) further disrupted the Burton Street Community, displacing both human residents and wildlife as homes and forests were destroyed.<sup>32</sup> I-240 has since joined Interstate 26 (I-26) in the Burton Street area and currently, an expansion of I-26 threatens encroachment of the Burton Street Community yet again. The Burton Street Community's leadership has created a sustainable plan for their neighborhood which seeks to protect greenspace and create backyard gardens among many other initiatives to help the Burton Street Community thrive.<sup>32</sup> The Burton Street neighborhood is composed of roughly 122 acres, 44% of which is covered in tree canopy.<sup>33</sup> Burton Street is located in a census block group which has a heat vulnerability value of 1.3, which is one of the highest values in the City of Asheville.<sup>30</sup>

### *2.1.3 east end/valley street*

The East End/Valley Street neighborhood, adjacent to the downtown area (Figure 3), is a historically black community that was severely fractured by urban renewal beginning in the 1950s.<sup>34</sup> The East End/Valley Street neighborhood was considered more "rural" than surrounding areas, as the community was able to feed itself with large gardens and poultry farming.<sup>35</sup> In an attempt to improve the neighborhood's living conditions, urban renewal displaced many residents and replaced many homes and buildings, as well as the gardens and greenery that existed around them, with highways, widened roads, and newer, taller buildings.<sup>34,35</sup> Currently, there are a few greenspaces near and within the neighborhood, most notably Martin Luther King Jr. Park and the Bountiful Cities Edible Garden which provides fresh food to the local community. Recognizing a recent surge in development as a threat to the community and its undeveloped land, the East End/Valley Street Association is actively working to "re-create that lost sense of community."<sup>36</sup> The East End/Valley Street neighborhood covers roughly 296 acres with 60% tree coverage<sup>30</sup> and, therefore, a relatively low heat vulnerability value of 0.6.<sup>30</sup> However, because over half of the neighborhood is covered in trees, the remaining undeveloped land may be at risk to the continued construction of housing units if left unprotected.

### *2.1.4 haw creek*

The Haw Creek neighborhood is located in the more rural area of northeastern Asheville (Figure 3). Between the community's agricultural roots, the Haw Creek running through the neighborhood, and the Blue Ridge Parkway adjacent, this neighborhood has always valued greenspace. The Haw Creek Community Association formed in 1983 to protect the character of the community and ensure that residents were involved in decisions affecting their neighborhood as it was being threatened by proposed developments.<sup>37</sup> Since then, Haw Creek residents have remained active to protect and improve the community. The neighborhood values its parks and nature trails as educational opportunities for community members and visitors. Haw Creek is a large neighborhood, totaling around 1555 acres, 62% of which is covered with trees.<sup>33</sup> This neighborhood spans across four different census block groups with HVI values ranging from 0.5 to 0.8, so this neighborhood is considered less vulnerable to the heat island effect mostly due to its high tree cover.<sup>30</sup> However, if left unprotected, remaining forested parcels are threatened by continued development.

### 2.1.5 *kenilworth*

The Kenilworth neighborhood is located in east Asheville, surrounded by East End/Valley Street and downtown, the commercial areas along Tunnel Road, and Biltmore Village (Figure 3). Kenilworth was established as a town in 1914, until the City of Asheville annexed it in 1929.<sup>38</sup> Across Kenilworth Lake, the Kenilworth Forest neighborhood started developing the 1940s.<sup>37</sup> Although they are considered separate neighborhoods, Kenilworth Residents Association and Kenilworth Forest Residents Association work together to balance preservation of the area's historical identity with the pressures of development. For purposes of this research, the two neighborhoods will be considered one community. The community's five parks, Kenilworth Lake, and high tree cover are important features of the community's identity—70% of the neighborhoods' 671 acres of land is covered with trees.<sup>35</sup> The community spans across census block group lines with HVI values ranging from 0.6 to 0.8.<sup>30</sup> The eastern and southern borders of the neighborhood, running along Tunnel Road and Swannanoa River Road respectively, are likely at the highest risk due to increasing commercial development along these roads; however, increasing residential development within the neighborhood is also threatening the community's internal urban trees.

## 2.2 Background Research and Study Design

A review of recent literature in the field of urban ecology and forestry was compiled. An ArcGIS StoryMap was created to present how the urban tree canopy of Asheville relates to human health, economics, and disparities in a relatively accessible format.<sup>39</sup> To better understand the state of Asheville's urban tree canopy and its current political landscape, the researcher became familiar with past and ongoing initiatives relating to Asheville's urban tree canopy, met with individuals who are actively involved with Asheville's urban tree canopy, and attended meetings and events of the Asheville Urban Forestry Commission, Asheville GreenWorks, the Tree Protection Task Force, and other relevant local groups. The researcher observed that current discussions surrounding Asheville's urban tree canopy reflect a deeper issue: the City of Asheville is struggling to balance development with preservation of greenspaces. The goals of this study are to provide an overview of the benefits of Asheville's urban tree canopy, identify experiences and perspectives that are shared among some Asheville residents, and provide suggestions for policy-makers, community groups, companies, and individuals so that the Asheville community may work together towards a future of sustainable development.

Four Asheville neighborhoods were chosen to study, predominantly due to their varying levels of tree canopy cover and HVI values.<sup>30</sup> Each neighborhood association's presence on Facebook was also considered when selecting neighborhoods, as it was presumed that an active Facebook page/group with many followers/members would ease the process of contacting neighborhood leaders and distributing the virtual survey. The detailed, intimate experiences and perspectives of individuals were obtained through interviews; the intention of the survey was to seek out more perspectives of less detail to compare and contrast with interview responses.

## 2.3 Data Collection and Analysis

Because this study involved surveying and interviewing community members, the researcher completed the CITI Training Program and then submitted their research proposal to the UNC Asheville Institutional Review Board (IRB). Upon receiving IRB approval, the researcher began to contact the neighborhood leadership groups of the four neighborhoods via email and Facebook Messenger, requesting their help to disseminate the call for interview and survey participants. Other local groups such as the Tree Protection Task Force and the Coalition of Asheville Neighborhoods, as well as other willing individuals, assisted with distributing the survey to Asheville residents. Because the goal of this research was to collect more qualitative data, and because time was limited, it was not possible to conduct a survey with a representative sample of Asheville residents.

The survey was created using Qualtrics software. Survey questions included a variety of formats, including multiple choice questions, prompts with space for short answers, as well as questions formatted as Likert scales.<sup>40</sup> Basic demographic information was also collected to learn more about the participants' backgrounds. The main intention was to compare survey data across the four chosen neighborhoods, although the invitation to participate in the survey was extended to all Asheville residents over the age of 18. The original interview strategy was to conduct a total of eight interviews with two residents from each of the four chosen neighborhoods. An interview guide was created with guiding questions to ask each interview participant; relevant follow-up questions were asked based on the individuals' responses.<sup>41</sup> Due to the qualitative nature of this research, most of the interview questions were open-ended, leaving room for each individual to share whatever information they felt was important and relevant. Interviews were recorded

with each participant's consent. Survey results were analyzed using Qualtrics' analysis tools. Qualitative methods were used to analyze the open-ended survey responses and the interview responses by comparing and contrasting the responses of residents, based around commonly mentioned themes.

### 3. Results

The following questions were explored in this research:

- What are the benefits associated with urban tree cover, in general, and specifically in Asheville, NC?
- What are the costs associated with lack of tree cover in general, and specifically in Asheville, NC?
- How do the residents of Asheville, NC, perceive and value the urban tree canopy?
- How might these experiences differ between neighborhoods?

Due to time constraints, six total interviews were completed. Two interview participants are residents of Burton Street Community, two from Haw Creek, one from Kenilworth, and one from East End/Valley Street. There were 36 total survey participants, 17 of which are residents of Haw Creek, 6 from East End/Valley Street, 2 from Kenilworth, 0 from Burton Street, and 11 from other Asheville neighborhoods. Although similar methods were used to contact and distribute the survey to each neighborhood, response rates differed. Due to the small and uneven sample sizes across neighborhoods, there were not enough survey responses from all four neighborhoods to compare data and trends across these neighborhoods exclusively—instead, the survey data was analyzed more holistically, including responses from Asheville residents who lived outside of these four neighborhoods.

#### 3.1 Urban Tree Canopy Benefits

Urban trees are crucial elements of the green infrastructure that helps cities to manage environmental health, human well-being, save money, and stimulate the economy. Responses from Asheville residents demonstrated appreciation for many of these services from Asheville's urban tree canopy. When survey and interview participants were asked to explain the physical sensations they associate with mature tree cover, many mentioned the cooler temperatures and relief from shade, the unique smells of natural settings (some described this smell as "green" or "humusy"), and the sounds of nature (most notably birdsong, the breeze rustling leaves, and the sounds of critters moving about). Figure 4 is a visual representation of some of these responses from survey and interview participants. It is recognized that the phrasing of this question in the survey may have impacted participants' answers, as relief from the sun was provided as an example in case participants were struggling to understand the question. The vast majority of survey and interview participants associated positive feelings with forested settings, for example, a sense of peace, relaxation, and stress relief. Many survey and interview participants described a connection with nature, expressing gratitude for the protection and comfort provided by the forest. Some residents expressed appreciation for the opportunity that trees and greenspaces provide to connect with other community members; one resident explained that the trees in their neighborhood "invite people outside." Some residents also explained how they feel that greenery has historically been an important part of their neighborhood's identity and the identity of Asheville as a whole. Many residents highly value seeing and hearing wildlife, such as birds, bears, and squirrels, within their neighborhoods.



Figure 4. Forested Areas Wordcloud

Figure 4. In both interviews and surveys, participants were asked to remember a place they have been with significant tree cover and describe what came to mind about their experience. The larger the word, the more often this concept was mentioned; smaller words were mentioned fewer times. Responses consisted of mostly positive associations with what they observed, smelled, heard, and felt (physically and metaphysically). The lower temperatures and relief from shade were some of the most commonly mentioned sensations. Many participants expressed an appreciation for the beauty, protection, and peace provided by trees and their inhabitants.

One survey question asked participants to rate, on a scale from 0 to 10, how much the trees in their neighborhood impact their quality of life. The average answer was 9.31, indicating that survey respondents believe the trees in their neighborhood have a considerable impact on their quality of life (Figure 5).

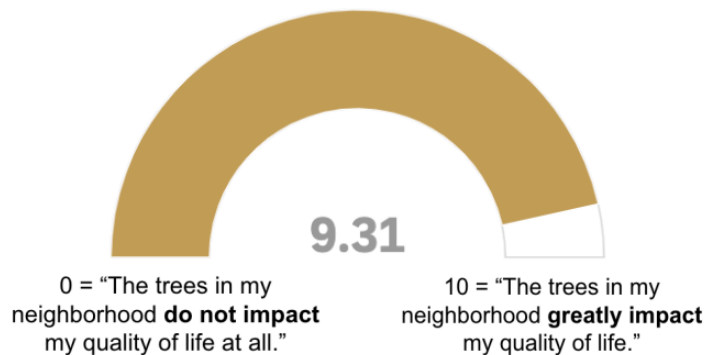


Figure 5. How much do the trees in your neighborhood impact your quality of life?

Figure 5. Survey respondents were asked to express, on a scale from 0 to 10, how much they feel trees impact their quality of life. The average response was 9.31 out of 10, which indicates that the participants feel that trees in their neighborhoods have a considerable impact on their quality of life.

### 3.2 Costs of Urban Tree Canopy Loss

Loss of urban tree canopy is accompanied by a loss of the services provided by urban trees. The urban heat island effect grows more intense as vegetation is removed and impervious surfaces replace what used to be natural areas, threatening human and environmental health. The Asheville heat vulnerability map demonstrates which areas in Asheville are the most vulnerable to the urban heat island effect.<sup>30</sup> The areas that are currently less vulnerable to the heat island effect have higher tree canopy coverage—if the trees in these areas are removed, then residents of that area will become more vulnerable to the urban heat island effect and associated costs. An urban tree canopy assessment conducted for the City of Asheville in 2019 found that the city lost 6.4% of its tree canopy cover, which translates to 891 acres, or 1.4 square miles, between 2008 and 2018.<sup>26</sup> The study then quantified the dollar amount of ecosystem services lost with these trees in terms of air quality, carbon storage and sequestration, and stormwater management: approximately \$8.7 million.<sup>26</sup>

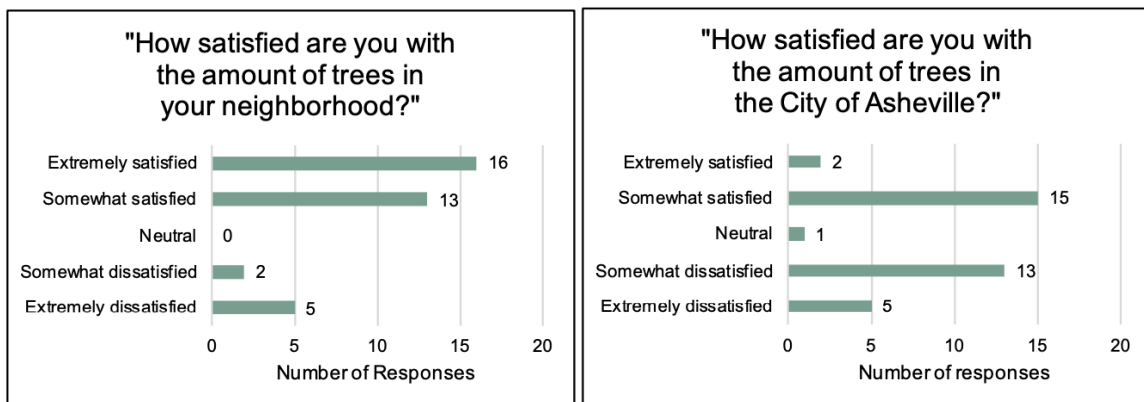
Many negative impacts of urban tree loss were demonstrated by survey and interview participants. In both the survey and interviews, residents were asked to imagine a place with little to no trees and describe what comes to mind. Intense heat is of the most common, and often the most notable, observations about urban areas with fewer trees. It is noted that the phrasing of this question may have increased the likelihood of participants to mention relief from shade, as this was provided as an example on the survey to help the participants better understand the question. In response to the question, some participants described urban areas that have been deforested, while some described ecosystems that naturally have fewer trees (i.e. desert & plains). Some participants mentioned this distinction—one survey response reads “for me there is a big difference between say a desert with no trees and a deforested area. I love the desert with the sun and brightness and different animals and smells. But a deforested area feels sad and desperate.” Analysis focused on the responses regarding deforested urban areas as this is the environment the participants were intended to envision, although the wording of the question was unclear. Words such as “bleak,” “lack of beauty,” “desolate,” “harsh,” “sterile,” “depressing,” “cementy” were used by participants to describe urban areas that have been deforested. Words such as “vulnerable,” “ancy,” “lonely,” “tension,” and “unprotected” were used to describe the participants’ experiences in these areas. Figure 6 is a visual representation of some of these concepts. One survey participant mentioned that urban trees are not able to thrive if they are isolated and lonely, as trees are intended to live in forests where they can communicate with other trees and interact with more organisms in a more complex ecosystem. Quite a few participants expressed a mentality of rushing to leave an urban area lacking trees—many mentioned that the frenetic energy is overwhelming, the temperatures are uncomfortable, and/or the lack of greenery is unsatisfying. Most residents noted hotter temperatures in urban areas with less trees; however, some noted colder temperatures too, as urban areas with few or no trees may experience higher wind speeds and therefore colder temperatures during colder seasons. A few residents have observed increased flooding as more trees are removed from their neighborhoods. There were some positive associations with urban areas lacking trees, such as an appreciation for more space to move and an increased feeling of safety due to the ability to better see one’s surroundings. Most of the participants expressed a preference for areas with many mature trees over urban areas with little to none.



Figure 6. Urban Areas Lacking Trees Wordcloud

Figure 6. In both interviews and surveys, participants were asked to remember a place they have been few to no trees and describe what came to mind about their experience. The larger the word, the more often this concept was mentioned; smaller words were mentioned fewer times. Responses consisted of less positive associations with spaces lacking trees. Extreme temperatures and direct sun were commonly mentioned. Many residents expressed something similar to a feeling of vulnerability due to the lack of tree cover.

While 81% of survey participants feel satisfied with the amount of trees in their neighborhood presently, only 47% feel satisfied with the amount of trees in Asheville as a whole. 78% of survey are concerned about the future of trees in their neighborhood and 89% are concerned about the future of trees in Asheville. These trends, represented in more detail in Figure 7, indicate that the vast majority of residents who participated in the survey are satisfied with the amount of trees in their neighborhood but are concerned about the future of these trees, along with all other Asheville trees. Some residents expressed concern that as trees are being removed from their neighborhood, and from Asheville as a whole, a portion of the area’s history and identity is being lost as well.



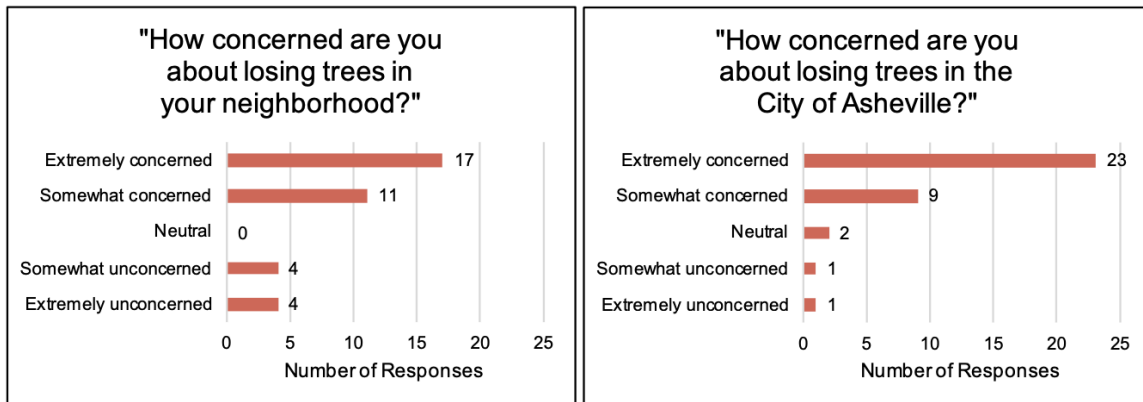


Figure 7. Survey Respondents' satisfaction with and concern about losing trees

Figure 7. Survey respondents were asked to express, on a scale from 1 to 5, how satisfied they are with the amount of trees in their neighborhood and in Asheville, as well as how concerned they are about losing trees in their neighborhood and in Asheville. The vast majority of survey respondents are both satisfied with the current amount of trees in their neighborhood and concerned about losing these trees. Survey respondents' satisfaction with the amount of trees in the City of Asheville varies, but the vast majority are concerned about losing trees in the city.

### 3.3 Residents' Perceptions of Trees

Below are overarching themes commonly mentioned by participants in surveys and interviews.

#### 3.3.1 connection with nature

In every interview, and many surveys, residents expressed some form of connection with nature. Many individuals noted that, in addition to the psychological and physiological effects of being in nature, they felt a metaphysical connection to nature. Most of the people who spoke of this connection often spent a lot of time in nature as children and, as they matured, felt it was important to their well-being to continue to live in environments surrounded by trees and other vegetation. Some individuals noted that even seeing the greenery and/or mountains through a window brings them peace. One interview participant noted that it is easy for people in our modern world to dissociate from nature long enough to no longer appreciate it and this dissociation may lead to activities that endanger urban forests. Therefore, a few participants claimed, it is especially important that we encourage younger generations to form connections with the natural world around them. One resident remarked that they have seen more individuals utilizing the greenways and parks in their neighborhood during the COVID-19 pandemic and speculated that many people have a shared experience of an increased appreciation for nearby greenspaces, as they've needed to reconnect with nature for their "sanity." Many participants expressed frustration, pain, discouragement, and grief when remembering the trees that they've watched disappear from their neighborhood and the city over time. Many individuals are not just concerned on the surface about losing trees, but seem deeply emotionally, and sometimes spiritually, affected by the idea of losing trees around them. Remaining urban forests may be the only opportunity for residents of Asheville to regularly come into contact with nature and wildlife, which enhances their connection with the natural environment around them.

#### 3.3.2 observations about development

Residents from many different neighborhoods across Asheville have noticed trends of increasing development in their neighborhoods and/or in the City as a whole. A majority of survey and interview participants are satisfied with the amount of trees in their neighborhood currently, but are very concerned about the future of the trees in their neighborhood due to the development trends they've noticed. There are countless reports of forested lots, often referred to as "undeveloped," being purchased by developers and clear-cut. The story sometimes ends with the developer subdividing the lot and cramming houses in, leaving no room for trees. Sometimes the lot is overrun by

invasive plants with no sign of development. Sometimes a structure is built and a few trees are planted on the lot, although it may take decades for them to provide significant benefits, if they survive. Many residents feel that the clear-cutting of entire lots is often unnecessary. Although it may cost some extra time and money to build around pre-existing trees on a lot, one interview participant claims, “at this point, the cost is worth the future ramifications” (referring to the long-term benefits of preserving mature trees). Many interview participants speculate that the motives of many development companies are profit-driven, with little to no consideration for the environment, especially because some developers are from out of the state and likely have little to no connection to the local community and environment. Many interview participants believe that it is very unlikely that developers will care about the environmental effects of their construction unless city policies make them care.

### *3.3.3 conservation in relation to other topics*

While many humans seem to agree that trees are good, this appreciation for trees may become less apparent once money and politics are involved. In political discussions, conservation is too often pitted against other issues. In Asheville, greenspace preservation often competes with the city’s need to build more housing. Many participants addressed that our city is indeed growing and we have a desperate need for affordable housing, so development is inevitable and not inherently bad. Unfortunately, some people have a preconceived notion that development and nature preservation are mutually exclusive. When asked about their opinion on this notion, most of the interviewees acknowledged that the two do indeed compete; however, they believe that both development and preservation can occur simultaneously in a sustainable way. Some residents even mentioned that affordable housing initiatives can (and should) include sustainable land management. Many interview participants advocated for the inclusion of a little bit of preservation in everything.

### *3.3.4 differing worldviews*

The idea of differing worldviews came up in many interviews—each individual has their own passions and priorities that leads them to act the way they do. From speculation throughout this research, four generalized archetypes of Asheville residents with regards to their attitudes about trees can be identified: (1) people who prioritize tree preservation, (2) people who care about trees, but other concerns take priority due to limited mental and energetic bandwidth, (3) people who tend to take trees for granted because they do not fully realize the benefits that trees provide, and (4) people who, regardless of their feelings about trees, tend to prioritize profit. This is not a comprehensive list and each person has their own unique vantage point; these four archetypes came up throughout multiple interviews. Time horizon was another common thread among many interviews: some people are more inclined to prioritize what is best for the community in the long term, while some people are more inclined to prioritize what is desirable for them in the immediate future. In a similar vein, another frequently mentioned sentiment was the idea that some people don’t realize the benefits of the urban tree canopy until they are in a situation in which they’ve lost or had limited access to trees and/or greenspace. By recognizing these different worldviews, one can develop compassion and understanding for each individual’s unique position and the decisions they make.

## 3.4 Comparison of Experiences Across Neighborhoods

Although the four neighborhoods have differing demographics, tree canopy coverage, and other factors, the experiences and perspectives of residents were more alike than expected. While circumstances are unique to each neighborhood, the residents interviewed from each neighborhood seem to be satisfied with the amount of trees in their neighborhood, but very concerned about the future of these trees. Residents from all four neighborhoods feel their trees are being threatened, regardless of their current tree canopy coverage. Survey results were inconclusive in terms of this research question due to varying response rates across neighborhoods.

## 4. Discussion and Conclusion

### 4.1 Discussion of Results

Asheville’s urban tree canopy provides infrastructure and ecosystem services that are important to wildlife, human residents, and the local economy. Asheville’s trees and greenspaces provide a unique sense of place that is highly

valued by many Asheville residents, as well as tourists and prospective new residents. The City of Asheville’s tree canopy covers nearly half of the city,<sup>26</sup> which is higher than the tree canopy coverage of Baltimore, MD,<sup>42</sup> and New York, NY,<sup>43</sup> and lower than that of Charlotte, NC,<sup>26</sup> Atlanta, GA,<sup>44</sup> and Raleigh, NC<sup>42</sup> (Table 1).

Table 1. Comparison of Tree Canopy Coverage of Cities in Eastern United States

City	Tree Canopy Coverage
Raleigh, North Carolina	55%
Atlanta, Georgia	48%
Charlotte, North Carolina	47%
Asheville, North Carolina	45%
Baltimore, Maryland	24%
New York, New York	21%

The aforementioned benefits of Asheville’s urban trees are diminishing, and will continue to diminish, with the destruction of the city’s urban tree canopy.<sup>26</sup> Asheville residents are noticing higher temperatures, worsened flooding, and wildlife displacement with increasing deforestation. Many interview and survey participants expressed an intense feeling of loss associated with tree removal, in some ways that are extremely difficult to quantify—for example, loss of community identity, historic value, aesthetic value, sacred spaces, and other deeply personal benefits. The vast majority of survey and interview participants are concerned for the future of the trees in Asheville, and development is one of the most commonly mentioned causes for tree removal.

In addition to individual- and community-level losses, urban tree canopy destruction also has negative impacts on the City of Asheville as a whole. Primarily, degraded urban forests are less able to provide opportunities for local mitigation and adaptation with regards to climate change.<sup>45</sup> That being said, while urban forests play an important role in resilience, a much more holistic approach is required to address the global issue of climate change.<sup>46</sup> Secondly, continued destruction of the urban tree canopy may contribute to tree disparities. Poor and non-white urban residents in the United States are disproportionately more affected by the urban heat island effect and its economic implications due to the varying amounts of trees across neighborhoods.<sup>47</sup> Thirdly, Asheville’s trees and natural areas are a major attraction for tourists and prospective residents. Because the Asheville economy relies so heavily on the tourism sector, significant urban tree canopy depletion may lead to serious economic turbulence. Finally, as Asheville continues to lose urban trees, the city continues to lose money as the urban forest’s ecosystem services, such as air quality improvements, carbon storage and sequestration, and stormwater management, are diminished.<sup>26</sup>

## 4.2 Opportunities Moving Forward

While development is a major threat to Asheville’s urban trees, the construction of residential housing is needed to support the city’s growing population. Development will inevitably be necessary as long as the human population is expanding. All of the interview participants agreed that it is possible to join tree preservation together with development—two topics that are often perceived as diametrically opposed. Given the current state of Asheville’s urban tree canopy, the city is presented with a great opportunity to pursue both tree preservation and construction of residential housing through sustainable development. Sustainable development equally values ecological, societal, and economic concerns, recognizing that the three are intertwined.<sup>48</sup>

The possibilities are endless to support protection and restoration of Asheville’s urban tree canopy. The following suggestions have been compiled from relevant literature and interviews conducted throughout this research. Figure 8 provides some opportunities for action to protect Asheville’s urban tree canopy that were shared by interview participants and/or encountered when compiling the literature review.

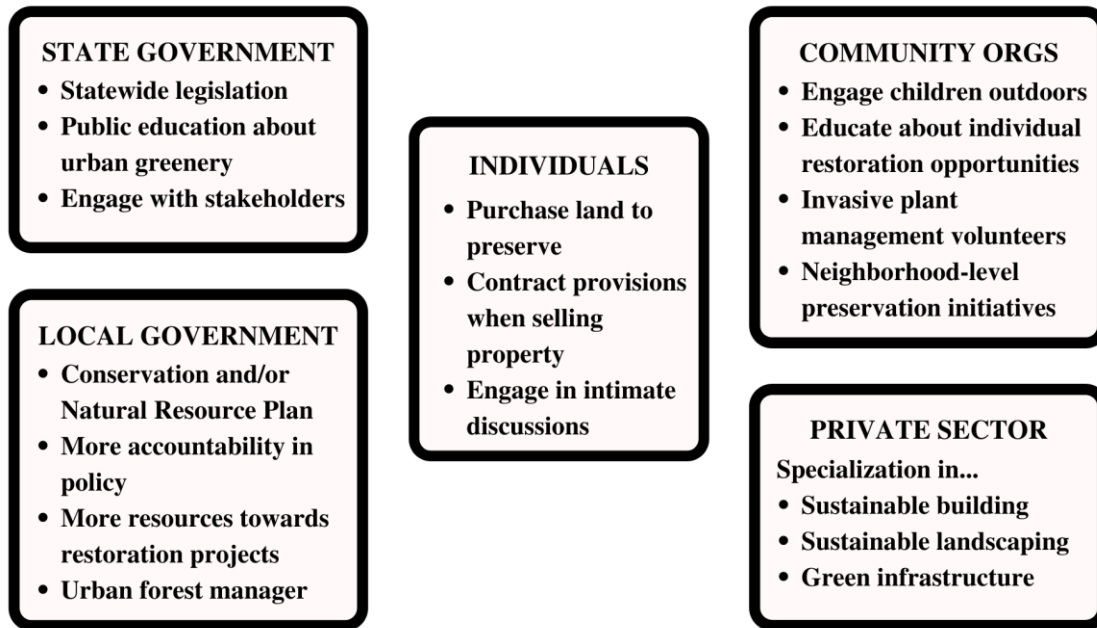


Figure 8. Potential opportunities for actions moving forward

Figure 8. Potential opportunities for actions moving forward are presented here. Actions are divided into state government, local government, private sector, community organizations, and individuals. Action is needed from all levels to work towards a more sustainable future. Ideas came from interviews and suggestions encountered in the literature review.

The North Carolina state government could create broad legislation providing regional protection for trees, which would help address impacts of development that transcend city boundaries. The state government could also implement more environmental education, specifically surrounding urban greenery, into public education. The state government should continue to engage with stakeholders who will be impacted by projects, as the Burton Street Community has been with the NC Department of Transportation.

The City of Asheville has a great opportunity to encourage sustainable development through policy. The city could create a conservation or natural resource plan, founded on the principles of sustainable development, as recommended by Asheville's Sustainability Plan of 2009.<sup>49</sup> This detailed plan would include setting aside land for conservation purposes. To strengthen standards surrounding tree removal at the parcel level, the city could put in place stricter ordinances that create more accountability surrounding tree removal, responsible planting of trees, and ecosystem restoration. For example, a new amendment or ordinance may increase tree canopy preservation requirements. It would be beneficial to more heavily penalize parties who opt for fee-in-lieu (an agreement in which a party pays a fee for removing more trees than they are allotted), or completely remove the fee-in-lieu option. Ultimately, the fee-in-lieu option is not ideal for every situation because even if this money is used to plant trees elsewhere, the individuals and wildlife living on and near the land in question are no longer able to access the benefits once provided by trees. City policy could also set in place tree planting requirements to ensure that trees are properly selected, planted, and maintained to ensure their longevity; certain tree species may fare better or worse in certain urban conditions do to heat, soil type, and stormwater tendencies.<sup>15</sup> One Asheville resident proposed the idea of including external certifications, such as Greenworks' Native Pollinator Garden, in the permitting process for development. Another resident proposed the idea of charging a large up-front fee to out-of-state developers who wish to develop in Asheville. A third resident proposed requiring new subdivisions to set aside a certain amount of acreage for conservation. The city could also put more resources into more intentional, site-level restoration projects on city-owned land. The urban ecology literature provides frameworks for urban restoration projects<sup>22</sup> and insight into incorporating biodiversity into restoration projects.<sup>50</sup> Similarly, the city may consider donating some resources to highly biodiverse areas that struggle with funding, such as the Asheville Botanical Gardens. Finally, hiring a full-time Urban Forest Manager would greatly assist the city throughout this process, as the person in this position could dedicate all of their time to coordinating these matters.

Preservation and restoration of trees presents new opportunities for companies to further specialize. For example, the pre-existing green building industry may further specialize by striving to preserve, and potentially restore, the natural landscape of the properties they are building on. This may especially be applicable to building affordable housing, as lower-income people are likely in the greatest need of the benefits of urban trees. Similarly, landscaping companies have a great opportunity to expand into restoration of native ecosystems on properties. A few interview participants noted that Asheville residents would likely be interested in rehabilitation projects on their property. Finally, creative urban green infrastructure represents a great opportunity for specialization. One resident mentioned that downtown Asheville would be a great place for green roofs. Green roofs and similar ideas, such as vertical greening systems, could provide better wildlife habitat, contribute to stormwater management and mitigation of the urban heat island effect, and contribute to the positive experiences of Asheville residents and visitors.<sup>51</sup> Creative specialization may lead to a surge of new green infrastructure because cities are centers for innovation and problem-solving.<sup>21</sup>

Community groups and non-profits also have opportunities to preserve and restore the urban tree canopy. Primarily, these organizations could intensify their initiatives to encourage children to appreciate nature; many residents expressed how feeling a connection to nature as children contributed to their passion for preserving it. Some community organizations, such as Asheville Greenworks, may prioritize environmental education to help their community understand the importance of trees and greenspaces and how to protect them. More specifically, education about how individuals can restore and protect native ecosystems in their backyards may inspire action. Local volunteer groups could be formed to help manage the invasive plants of Asheville and replace them with native species. Finally, neighborhoods can explore implementing tree restrictions in their neighborhoods through their Homeowners' Associations.

It is ultimately up to individuals to create change. A small group of neighbors in Kenilworth noticed that a nearby plot of forested land was in danger of clearcutting and subdivision so they gathered enough money to purchase and preserve it. When selling property, individuals can look into restrictive covenants that may limit the amount of trees the buyer will be allowed to remove. Two more actions to be taken by individuals which are totally free, yet potentially the most impactful, are to deeply reflect on the part oneself plays in the process of tree preservation and to engage in meaningful discussions with others about the importance of nature.

### 4.3 Suggestions for Future Research

It is possible that individuals who greatly value trees were more likely to respond to the survey and/or express interest in participating in an interview. The goal of this research was not to capture a representative sample of how all Asheville residents feel, rather, to capture the unique, intimate experiences of individuals with regards to urban trees, as the researcher felt that qualitative data would be more meaningful in this context. Future research, with more time and resources, may seek a more representative survey of all Asheville residents' perceptions of the urban tree canopy if more quantitative data is desired. Any future research involving community engagement should strongly consider the importance of building trust between the researcher and the communities. The process of building trust is may be a lengthy process, but is incredibly important. Communities may be skeptical of researchers, rightfully so, and it is important that the researchers demonstrate genuine care for the well-being of community members, intention to portray these communities accurately and fairly, and commitment to follow through with action to benefit the community.

Other future research may seek to understand how socioeconomic factors may be related to access to greenspaces and how historically marginalized people disproportionately experience economic burdens of insufficient tree cover. More specifically, research may begin with Asheville's history of redlining and urban renewal and how these processes may have facilitated the degradation of urban forests in these areas. Other research may consist of cost benefit analyses to evaluate the pros and cons of developing certain areas (such as the Ravenscroft Reserve); however, this cost benefit analysis should be completed with great care as many values of the urban tree canopy are difficult, or sometimes impossible, to quantify (i.e. metaphysical benefits such as connection to nature). More research should be done surrounding sustainable development and Asheville may be a great study site for this research given the city's rapidly growing population and desire to preserve the urban forest. Site-specific ecological research may assist in making decisions surrounding management and restoration of forested areas by helping the managers better understand the needs of local ecosystems. Research into the psychology behind decisions impacting the urban tree canopy, such as perception of time (i.e. short term vs. long term thinking) and connection to nature may be helpful as understanding humans' underlying thought processes may help generate understanding for one another, allowing for more productive conversations.

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