VIRGINIA TECH™

BLACKSBURG CAMPUS URBAN FOREST MASTER PLAN

2023

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ACKNOWLEDGMENTS

LAND ACKNOWLEDGMENT

Virginia Tech acknowledges that we live and work on the Tutelo / Monacan People's homeland, and we recognize their continued relationships with their lands and waterways. We further acknowledge that the Morrill Land-Grant College Act (1862) enabled the commonwealth of Virginia to finance and found Virginia Tech through the forced removal of Native Nations from their lands in western territories. We understand that honoring Native Peoples without explicit material commitments falls short of our institutional responsibilities. Through sustained, transparent, and meaningful engagement with the Tutelo / Monacan Peoples, and other Native Nations, we commit to changing the trajectory of Virginia Tech's history by increasing Indigenous student, staff, and faculty recruitment and retention, diversifying course offerings, and meeting the growing needs of all Virginia tribes and supporting their sovereignty.

LABOR RECOGNITION

Virginia Tech acknowledges that its Blacksburg campus sits partly on land that was previously the site of the Smithfield and Solitude Plantations, owned by members of the Preston family. Between the 1770s and the 1860s, the Prestons and other local White families that owned parcels of what became Virginia Tech also owned hundreds of enslaved people. We acknowledge that enslaved Black people generated wealth that financed the predecessor institution to Virginia Tech, the Preston and Olin Institute, and they also worked on construction of its building. Not until 1953, however, was the first Black student permitted to enroll. Through InclusiveVT, the institutional and individual commitment to *Ut Prosim* (that I may serve) in the spirit of community, diversity, and excellence, we commit to advancing a more diverse, equitable, and inclusive community.

This document represents the culmination of Virginia Tech's commitment to natural resource conservation and professional urban forest management on the Blacksburg, VA campus.

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Executive Summary

"Virginia Tech shall ensure its community has the opportunity to enjoy the campus Urban Tree Canopy for generations to come"

Mission

Virginia Tech's campus in Blacksburg, Virginia, encompasses about 900 acres and is home to more than 11,500 living trees and several forests. Virginia Tech's Blacksburg campus is the urban nucleus for the immediate region. The example Virginia Tech sets for ethical and professional management and conservation of the campus urban forests significantly influences the university community and surrounding region while supporting the Virginia Tech Climate Action Commitment.

The Virginia Tech Blacksburg Campus Urban Forest Master Plan establishes a vision that will guide the Virginia Tech Division of Campus Planning, Infrastructure, and Facilities and the University Arborist as they manage campus natural resources and care for Virginia Tech's trees:

> *"Virginia Tech shall ensure its community has the opportunity to enjoy the campus UTC for generations to come, through adaptive, professional, ethical, and sustainable management of the urban forest located on university properties."*

Critical Challenges

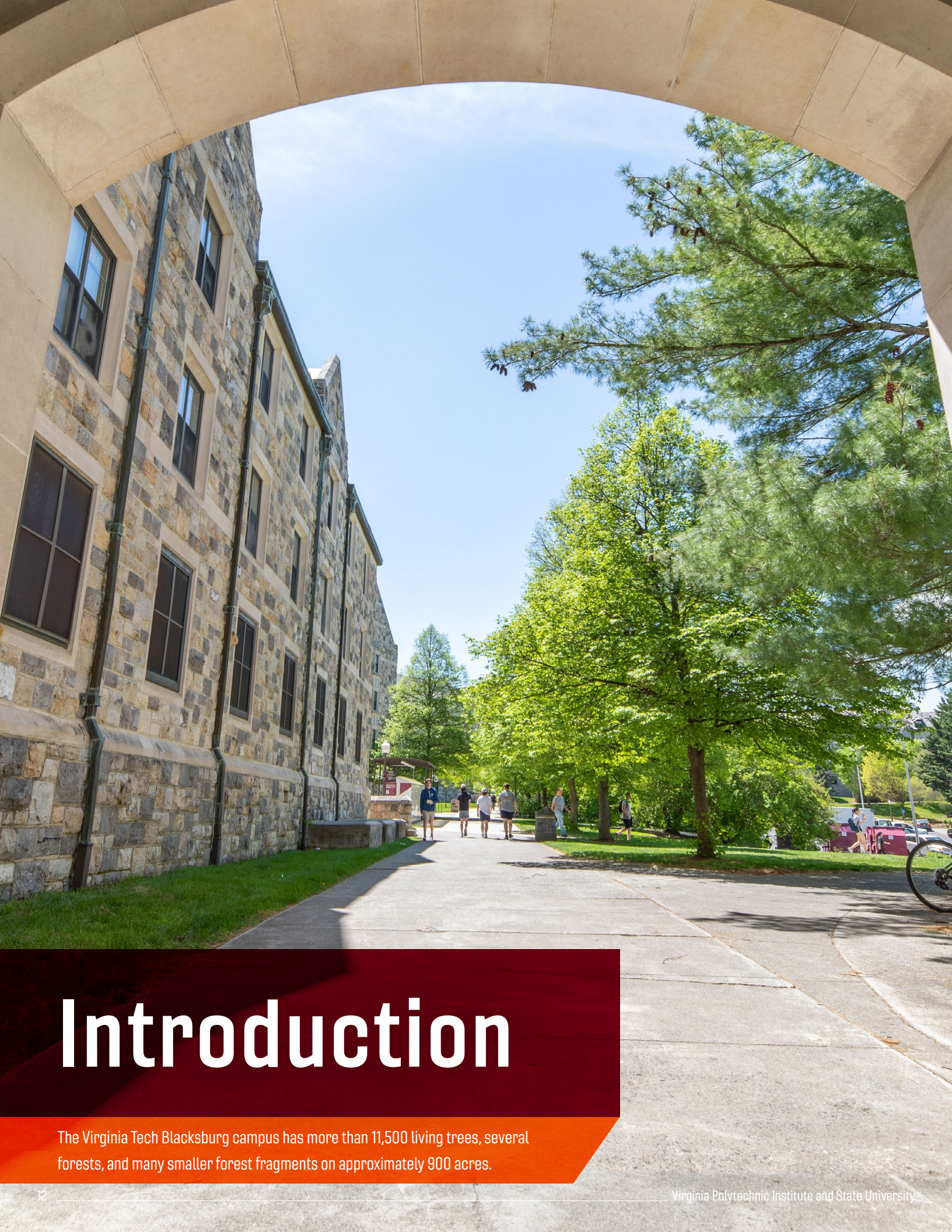
- Currently, the UTC (urban tree canopy) (the surface area on campus covered by tree leaves) is 14.7 percent, low when compared to other urban areas in our region.
- Historically, tree maintenance was addressed on a request basis resulting in a backlog of pruning, plant health care, and tree removal needs.
- Limited resources for responsive maintenance are stretched between competing priorities resulting in a persistent and growing backlog.
- No resources are allocated for routine maintenance which inflates expenses related to responsive maintenance and exposes the Virginia Tech community to increased risk.
- Various tree planting efforts have resulted in a patchwork of young trees with no central objective, maintenance plan, or strategic tree canopy management plan.
- The lack of a Tree Policy continues to challenge tree asset protection from campus development, during construction activities, and fulfillment of our Climate Action Commitment goals.

Goals

- Establish a Virginia Tech Tree Policy that empowers the Division of Campus Planning, Infrastructure, and Facilities and the University Arborist to fulfill the objectives envisioned in this plan.
- Institute an Urban Tree Canopy Goal that supports Virginia Tech's ongoing Climate Action Commitment.
- Preserve low risk, resilient, valuable, and attractive trees on campus.
- Maximize the cultural, ecological, and aesthetic benefits provided by Virginia Tech's urban forest.
- Provide opportunities for teaching, learning, research, and recreation on a campus that is safe, comfortable, and beautiful.
- Set an example for universities pursuing comprehensive urban forestry management programs.
- Represent a concerted effort by the division to conserve natural resources and operate an environmentally sustainable and climate-resilient campus.

Major Recommendations

- Adopt the Virginia Tech Urban Forest Master Plan, the Virginia Tech Tree Policy, and the Urban Tree Canopy Goal.
- Secure funding for comprehensive urban forest management at Virginia Tech.
- Recruit personnel for maintenance and management capacity.
- Engage stakeholders in operational planning and share results with the community quarterly.
- Develop an urban forest management plan and implement forest stewardship plans.
- Institute a tree emergency response system.
- Resolve the tree maintenance backlog.
- Institute routine tree maintenance on campus.
- Establish comprehensive tree asset replacement and pursue net gain tree planting programming.
- Institute effective tree protection and preservation programming.
- Plan and schedule educational events for the public and develop a community tree stewardship program.



Introduction

The Virginia Tech Blacksburg campus has more than 11,500 living trees, several forests, and many smaller forest fragments on approximately 900 acres.

Background

For more than 150 years, Virginia Polytechnic Institute and State University (Virginia Tech) has established a legacy of education, leadership, and service to students and the broader university community. Throughout these years, the Virginia Tech community has placed great value on the trees at the university's Blacksburg campus. These trees form an urban tree canopy that has been cultivated for generations and continues to provide a multitude of ecological, cultural, economic, and academic benefits to the community. Most importantly, campus trees help make Virginia Tech a beautiful, comfortable, and safe place to live, learn, work, and play.

Mission

Virginia Tech is the urban nucleus for the immediate region and the university sets an example in how this valuable urban forest is managed. As the university grows and infill development and large-scale renovations further urbanize the campus, community trees will face increasingly stressful site conditions. Management of trees throughout those challenges helps ensure the benefits they provide are maximized, helping mitigate the physical and psychological impacts induced by the hardened environment.

Providing a sustainable urban tree canopy for the benefit of the Virginia Tech community requires urban forest management programs, including:

- regular tree asset assessment
- long-term planning and short-term operational documents
- robust routine and responsive maintenance
- tree care, preservation, and protection standards
- tree asset replacement and new tree planting programming
- community engagement activities

Recognizing the need for a sustainable urban tree canopy, existing resources, challenges, and opportunities were analyzed; then, industry standards were applied to develop the Virginia Tech Blacksburg Campus Urban Forest Master Plan.

Vision

The Virginia Tech Blacksburg Campus Urban Forest Master Plan establishes a vision that will guide the division and the University Arborist as they manage campus natural resources and care for Virginia Tech's trees:

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- Set an example for universities pursuing comprehensive urban forestry management programs.
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How to Use This Plan

Virginia Tech made natural resource conservation a priority in the autumn of 2019.

Guiding Principles

Forming the foundation of this plan are principles linked directly to what trees do for people and how communities decide to manage those trees. This section focuses on the benefits trees provide to the Virginia Tech community and the management approach that maximizes those benefits, from assessment and planning to maintenance with continuous monitoring and adaptation.

Current Conditions

Virginia Tech's urban forest forms an urban tree canopy over the campus, comprised of individual trees of various species, size, and age. This section illustrates the canopy cover, tree inventory, values, and benefits provided by the university's trees.

Analysis

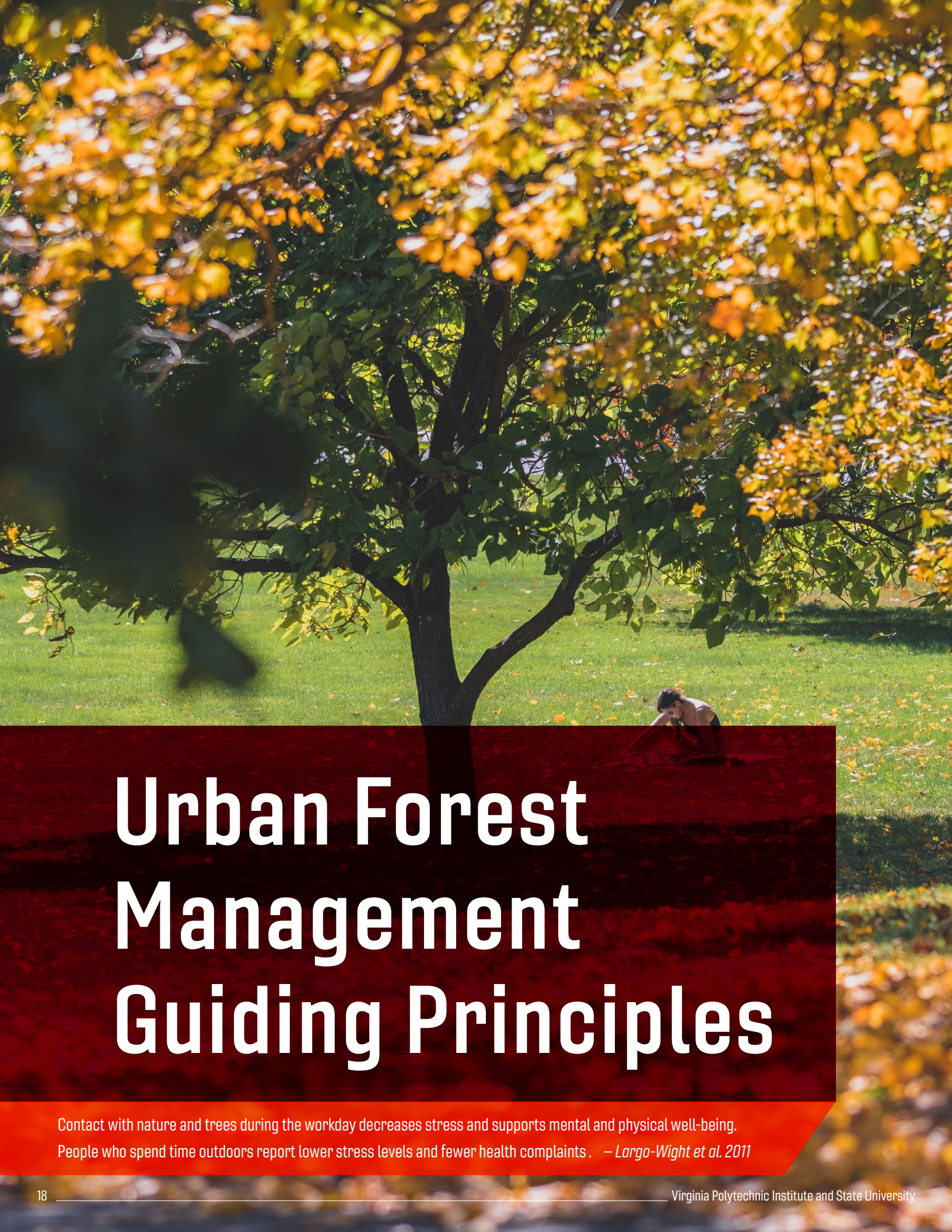
The current state of programming focused on urban forest assets at the university's Blacksburg campus is ever-changing. Current assessments of these programs— including administration, maintenance, planting, conservation, public engagement, and outreach—and the resources necessary to operate urban forestry at Virginia Tech are detailed in this section.

Recommendations

Building capacity to care for Virginia Tech's trees and grow a larger more resilient tree canopy is dependent on strategic development. These recommendations outline the administrative, operational, and budgetary steps that will establish comprehensive urban forest management for the Blacksburg campus community.

Path to Success

Virginia Tech made natural resource conservation a priority when the University Arborist began developing this plan in the autumn of 2019. Each recommendation detailed in this plan is summarized and prioritized in this section.



Urban Forest Management Guiding Principles

Contact with nature and trees during the workday decreases stress and supports mental and physical well-being. People who spend time outdoors report lower stress levels and fewer health complaints . *– Largo-Wight et al. 2011*

Tree Benefits and Values

Trees provide many benefits, values, and services to communities that improve human health, environmental quality, urban livability, and academic opportunities. These values are compounded on college campuses where diverse communities congregate to live, learn, work, and play. Research concerning students' preferences show that the appearance of an institution's grounds and facilities is one of the key factors when deciding where to spend their college years (Jackson 2002). Campus trees create special places that offer respite to the public; well-planned and maintained urban forests maximize these benefits resulting in more competitive universities and healthier, happier communities.

COMMUNITY HEALTH AND WELL-BEING

Contact with nature influences community physical and mental health substantially:

- When personal connections with nature are enhanced, people experience improvements in both cognitive performance and mental well-being, along with a decrease in instances of mental health-related illnesses (USDA 2018).
- Tree leaves filter the air and remove particulate matter, while reducing pollution caused by carbon dioxide, ozone, sulfur dioxide, and nitrogen dioxide; this ecological service improves air quality and human health (Lovasi et al. 2008).
- Contact with nature and trees during the workday decreases stress and supports mental and physical well-being. People who spend time outdoors report lower stress levels and fewer health complaints (Largo-Wight et al. 2011).

These benefits are of great importance at Virginia Tech where students, teachers, researchers, and administrators will perform at a higher level and with a greater sense of satisfaction on a campus where tree benefits are maximized.

ECOLOGICAL BENEFITS

The environmental benefits of trees are well documented:

- Trees clean the air and water in communities.
- Urban forests sequester and store atmospheric carbon, offsetting part of society's carbon footprint.
- Tree leaves cool the air and reduce energy expenses while making outdoor spaces more comfortable.
- Urban trees provide valuable wildlife habitat in public spaces where wildlife would be scarce otherwise.

These benefits are maximized when tree populations are large, diverse, and routinely managed to industry standards. The ecological services provided by large trees are especially valuable and important in urbanized areas dominated by hardscape and buildings. This dynamic between trees and facilities makes site planning and tree protection during construction a crucial component of urban forest management.

Integrated and Adaptive Management

The trees at Virginia Tech are assets that require professional management to maximize the benefits they provide and increase the university's return on investment. Urban forest management, like the management of other natural resources, is in the public's interest where an integrated and adaptive approach informs programmatic planning and implementation (Figure 1).

Figure 1. Urban Forest Management: Concept to Implementation

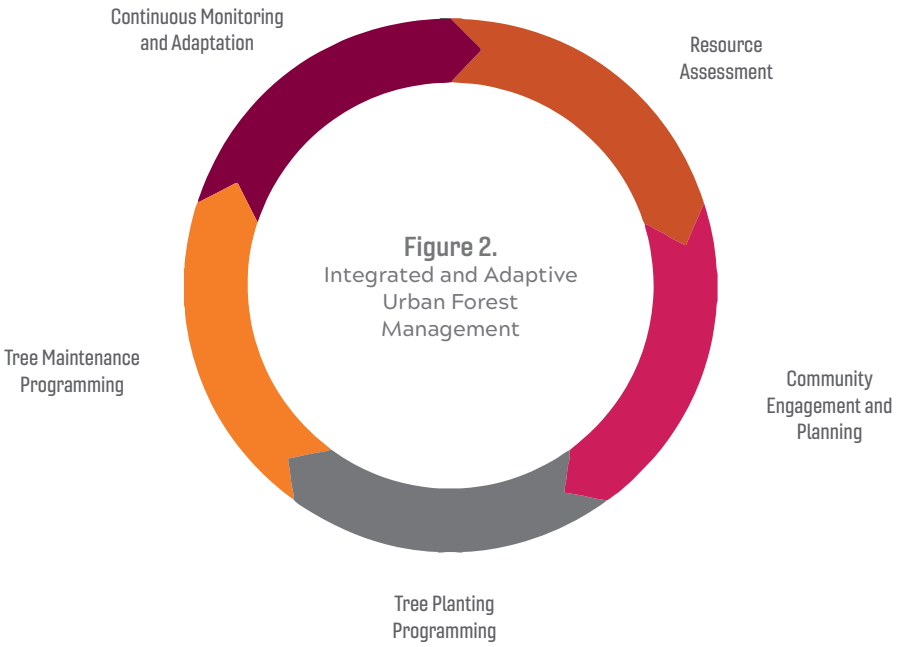


Figure 2.
Integrated and Adaptive Urban Forest Management

Integrated and adaptive urban forest management relies on continuous monitoring of assets and programming. This due diligence informs revisions to plans and adaptations in strategies so managers can prevent conflict and reduce waste (Figure 2). This approach allows managers to respond to changes, prevent conflicts, and reduce waste.

ASSESS

The first step in urban forest management is assessing the urban tree canopy and inventorying the tree population. Assessments should be reviewed and updated on a regular basis.

The urban tree canopy (UTC) is the percentage of ground surface covered by tree leaves in a community. This number establishes a baseline for urban forest size and location. The UTC is compared to other ground covers like impervious surfaces, turf/grass, and building rooftops to identify space available for tree planting and help establish an urban tree canopy goal. This metric is the percentage of land area that maximizes community benefits from the urban forest and gives urban forest managers a measure to inform program development.

A complete tree inventory is a census of trees to be managed within a community. This database records the identity (species, size, and condition) of each tree and its exact location. Inventories help urban forest managers plan for the maintenance of trees in the community and assess the tree population for vulnerabilities to pests, disease, and other threats.

ENGAGE AND PLAN

Integrated and adaptive natural resource management engages community stakeholders in urban forest planning with the purpose of facilitating transparency, enhancing customer service, and adding capacity. The coalition works together to establish a mission for the urban forest manager to plan and implement.

Urban forest management is a government service where citizens, researchers, natural resource professionals, public servants, and other stakeholders have a voice throughout the planning process. Public engagement occurs through speaking engagements, media outreach, and educational tree planting or public service events.

Urban forest master plans are long-range documents that cover all or most topics related to urban forest management in a community. They assess current conditions, establish a vision, set priorities and goals, and make recommendations or suggest action items for managers and leaders to pursue through management plans and operations.

Urban forest management consists of many operations including tree monitoring, maintenance, and planting, along with risk management, storm response, tree protection, and others. Larger operations, like tree maintenance and planting, benefit from short-range adaptive planning documents that guide operations toward goals established in the master plan. Smaller operations like risk management and tree protection may be implemented through standards and procedures.

MAINTAIN

Trees growing in urban environments require regular inspection and maintenance to reduce risk to the public by ensuring good tree health and sound structure. This routine maintenance is the core of urban forest management and maximizes the public's return on investment, providing longer-lived and more attractive trees while reducing risk.

- Tree inspection is the first step of routine maintenance. Scheduled tree inspections conducted on a regular cycle can identify tree or site problems or conditions that may become problematic; this due diligence gives the urban forest manager opportunities to plan and implement mitigation strategies.

- General tree care:
  - Structural pruning is the practice of correcting problematic branch structure in a tree before the condition worsens. This helps establish and maintain a stable structure and is sometimes called "training" for young trees.

- Maintenance pruning is required to prevent or correct tree branches that conflict with infrastructure or the public. Dead or diseased branches may be removed and tree crowns may be shaped through pruning to provide clearance along roads and sidewalks or near buildings.
- Risk mitigation pruning is the practice of reducing the length or leaf area of limbs, or removing limbs to limit the likelihood of branch or tree failure.
- Plant health care is the management of a tree and the site to support good health and improve resistance to pests and disease.
- Tree removal is the process of dismantling and disposal or reuse of trees after they have surpassed their useful life; examples include trees that are dead, damaged, or diseased that may be of elevated risk to the public and property.

After seasonal storms and less frequent extreme weather events, emergency inspection or response, tree debris removal, tree pruning, and tree removal may be necessary to abate risk to the public, preserve tree assets, and reduce the disruption of activities and services.

- Emergency preparation planning allocates staff and other resources to storm damage prevention, mitigation, and cleanup. Locations are prioritized to minimize risk and disruption during storm response.
- Tree inspections triage incidents so the response is orderly and efficient.
- Some damaged trees may be pruned for preservation but other trees with serious structural damage will require removal.
- Well-maintained trees are more resilient to storms, requiring less response during and after weather emergencies.

PLANT

Sustaining the urban canopy requires tree planting to replace trees and expand canopy at unforested sites.

Trees in the landscape are removed for various reasons; natural death, urban development, long-lasting repercussions of construction activities, risk mitigation, and storm damage are the most common. Replacement of these trees is important to maintain the urban canopy.

Plantable spaces are sites with adequate soil conditions for tree planting that are not currently forested. These sites are opportunities for urban canopy expansion and are targeted for tree planting. Trees are most valuable when they are located within highly urbanized areas where they provide the largest ecological, physical, economic, and psychological benefits for the community.

MONITOR AND ADAPT

- The urban forest is a complex system; stakeholders are diverse and trees are vulnerable to various stresses and threats. Adaptation must occur throughout the management process to ensure current science and community support are understood and implemented. Continual reassessment of the urban forest master plan and operational plans is important to maintain a viable vision.

- Continuous community engagement helps build support for urban forestry programming and keeps the urban forest manager in touch with stakeholders.
- Arboriculture, the art and science of tree care, is the foundation of urban forestry. Advancements in arboriculture science, practice, and techniques occur rapidly and practitioners must remain actively engaged in the industry to remain relevant. Continuous monitoring throughout operations helps adapt urban forestry programs to improve results.
- Reassessment of resources and analysis is important when adapting the urban forest master plan and associated goals like the UTC.

Virginia Tech Blacksburg Campus Urban Forest

The Old-Growth Forest near Lane Stadium is the remainder of a late successional white oak forest with trees over 300 years old.

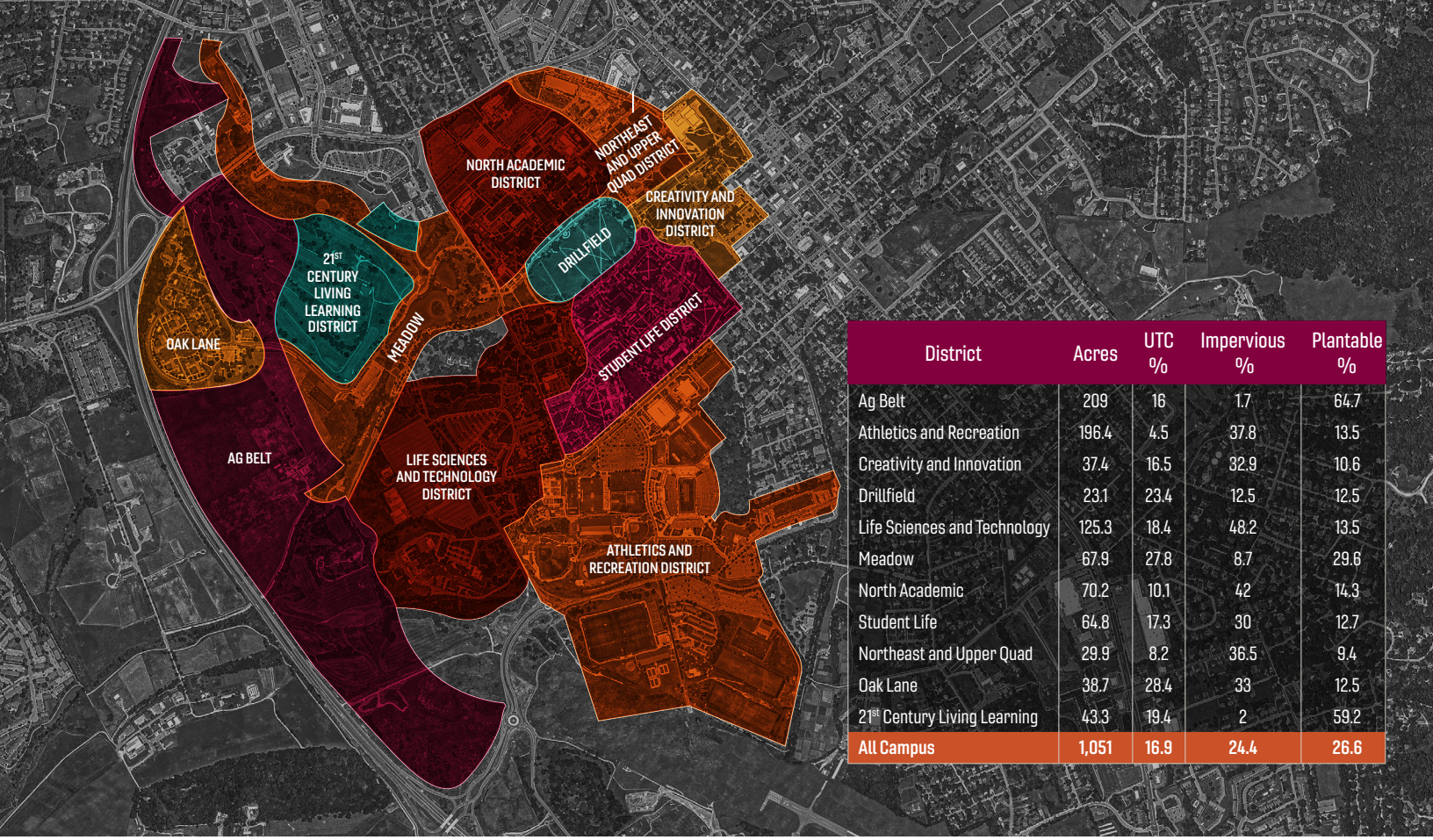
Canopy Cover

Virginia Tech's urban tree canopy (UTC) is the percentage of campus that is covered by tree leaves during the growing season and can be used for setting goals and planning throughout operations and development. Communities with larger UTCs enjoy greater tree benefits while communities with lower UTCs have more room for improvement. Urban forest managers compare the UTC with other ground covers like rooftops, roads and sidewalks, and grass to establish a tree canopy goal that directs tree planting and preservation plans. Table 1 compares Virginia Tech to SCHEV-Approved Peer Institutions and some municipalities with similar climates to Blacksburg, Virginia that have adopted UTC goals.

Table 1. Urban Tree Canopy (UTC) Comparisons

Community	Current UTC	UTC Goal	Reference
Annapolis, Maryland	41%	50%	annapolis.gov/DocumentCenter/View/995/2006-Urban-Tree-Cover-Report-PDF
Atlanta, Georgia	47.9%	Increase	atlantaga.gov/Home/ShowDocument?id=14722
Cornell University	Not Reported	25%	fcs.cornell.edu/departments/office-u niversity-architect/campus-planning/tree-campus-usa
Leesburg, Virginia	27%	40%	leesburgva.gov/home/showdocument?id=1003
Ohio State University	13%	26%	kb.osu.edu/bitstream/handle/1811/76747/1/ENRAEDE4567_treecanopygroup_sp2016.pdf
Indiana University - Purdue University Columbus	14.2%	20%	iupuc.edu/about/sustainability/partnerships/arbor-day
University of Maryland	24%	40%	arboretum.umd.edu/sites/default/files/documents/2017TreeManagementPlan.pdf
University of Michigan	25%	40%	michigantoday.umich.edu/2013/09/17/a8696/
University of Pittsburgh	Not Reported	Increased by 50%	pitt.edu/pittwire/features-articles/duos-mission-count-each-tree-campus
University of Washington	20.9%	23%	facilities.uw.edu/files/media/2016-urban-forest-management-plan.pdf
Virginia Tech	14.7%	None	vtechworks.lib.vt.edu/bitstream/handle/10919/96647/Hwang%20and%20 Wiseman_01_2020.pdf
Washington D.C.	38%	40%	caseytreesdc.github.io/treereportcard2018

Currently, the UTC at Virginia Tech is 14.7% (Hwang and Wiseman 2020).



District	Acres	UTC %	Impervious %	Plantable %
Ag Belt	209	16	1.7	64.7
Athletics and Recreation	196.4	4.5	37.8	13.5
Creativity and Innovation	37.4	16.5	32.9	10.6
Drillfield	23.1	23.4	12.5	12.5
Life Sciences and Technology	125.3	18.4	48.2	13.5
Meadow	67.9	27.8	8.7	29.6
North Academic	70.2	10.1	42	14.3
Student Life	64.8	17.3	30	12.7
Northeast and Upper Quad	29.9	8.2	36.5	9.4
Oak Lane	38.7	28.4	33	12.5
21st Century Living Learning	43.3	19.4	2	59.2
All Campus	**1,051**	**16.9**	**24.4**	**26.6**

Figure 3. Campus District Overlay and 2020 i-Tree Canopy Study Data

In 2019, 8.7% of colleges and universities in the US reported having a campus tree cover goal, with 12.2% currently working on developing one (Schmitt-Harsh 2019).

Over the winter of 2019-2020, students in the Urban and Community Forestry course at the Virginia Tech College of Natural Resources and the Environment (CNRE) conducted a sample-based photo interpretation UTC assessment of campus districts (Byers and Wiseman 2020). The students utilized an application called i-Tree Canopy, a software developed by the United States Forest Service, that combines aerial photographs with ecosystem models to determine estimates of land cover types and the ecosystem services provided by UTC cover at specific locations.

This land cover data is created through a process called sample-based photo interpretation where analysts classify land cover types through statistical point sampling, allowing fast and inexpensive UTC reports. The i-Tree results report 16.9% UTC campus-wide, allowing comparison of UTC and ground cover data between districts across the campus. The results only differ slightly from the earlier Hwang and Wiseman 2020 study (14.7% campus-wide) due to differences in imagery dates and analysis methods. The final report illustrates the UTC relative to other ground covers in each zone on campus and the results of the primary campus districts are illustrated in Figure 3.

Figure 4. Live Tree Population from Campus Tree Inventory

Districts with high UTC include Oak Lane (28.4% or 10.9 acres), Meadow (27.8% or 18.9 acres), and Drillfield (23.4% or 5.4 acres). The Drillfield district tree canopy is relatively high when considering the canopy is restricted to the edges of the Drillfield district. These districts show great contrast when compared to districts with low UTC like Athletics and Recreation (4.5% or 8.3 acres), North Academic (10.1% or 7 acres), and Northeast and Upper Quad (8.2% or 2.4 acres). This assessment informs tree planting and preservation priorities across the campus as more complete tree planting and preservation plans are developed.

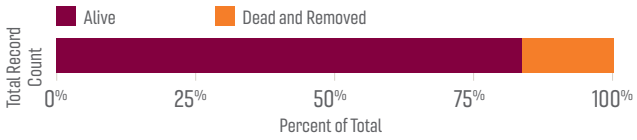
The proposed Virginia Tech Tree Policy sets an urban tree canopy goal of 25%, an increase of tree leaf area equivalent to 108 acres, by 2050. When approaching this new goal, campus districts with relatively low UTC and relatively high impervious surface may be prioritized for UTC expansion. Other priorities to enhance the benefits of incremental progress towards the 25% goal include identifying planting sites directly adjacent to thoroughfares and gathering places, where tree benefits like shade, evaporational cooling, and stress relief are maximized. Examples of districts where quick progress towards the goal may be seen include those with low UTC like Athletics and Recreation, North Academic, and Northeast and Upper Quad. Commitment to this goal will require resources for urban forest management to implement maintenance, planting, and preservation strategies that protect, maintain, and grow the urban canopy.

Campus Forest Population and Structure

A complete field inventory of trees on Virginia Tech's Blacksburg campus was completed in 2018. The resulting report was fundamental throughout the development of this plan and the report can be obtained at facilities.vt.edu.

The graphical representation of the Campus Tree Inventory is seen in Figure 4. White dots indicate general campus trees and orange dots indicate trees in the Old-Growth Forest near Lane Stadium. Some urban trees and various larger forests are not included and will require inventory and assessment in the future.

Figure 5. Live Tree Total from Campus Tree Inventory



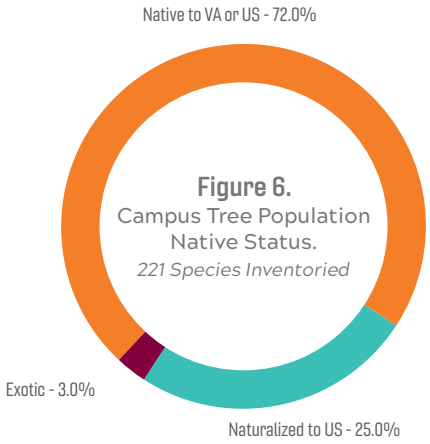
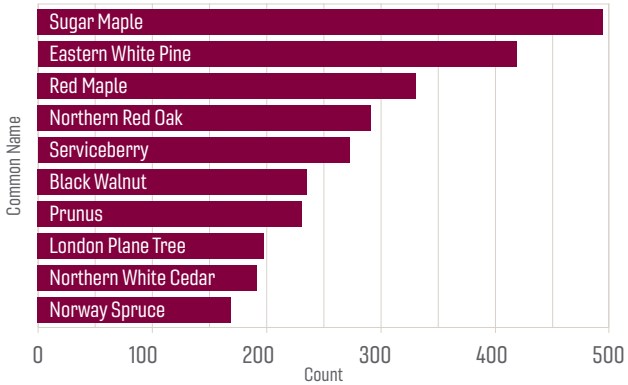


Figure 6.
Campus Tree Population Native Status.
221 Species Inventoried

Figure 7. 10 Most Abundant Tree Species on the Blacksburg Campus

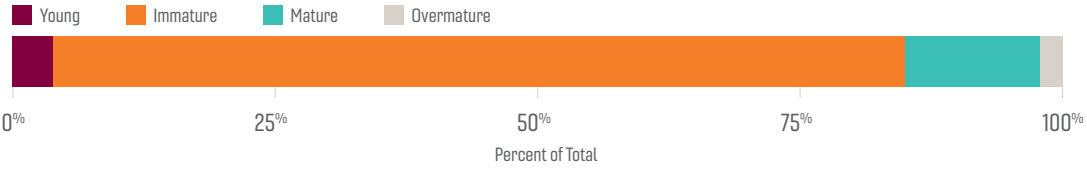


The tree inventory at Virginia Tech changes every day as maintenance and inventory work across campus progresses. As of November 2022 the Blacksburg campus is home to approximately 11,500 living trees and a total of 13,700 records are logged in the Core Campus Tree Inventory. This analysis is focused on the inventoried population as of April 24, 2020, when 8,911 trees were living and 1,742 had died or been removed (Figure 5).

A total of 221 different species were identified on the Blacksburg campus. Trees that are native to Virginia or the United States composed 72% of the inventory. Only 3% of the trees in the inventory are considered exotic and these trees are largely part of the Hahn Horticulture Garden (Figure 6).

The ten most abundant species inventoried on campus include large shade trees, ornamental conifers, and some small flowering trees (Figure 7). Diversity is important to support urban forest resilience to

Figure 8. Tree Population Age Classes



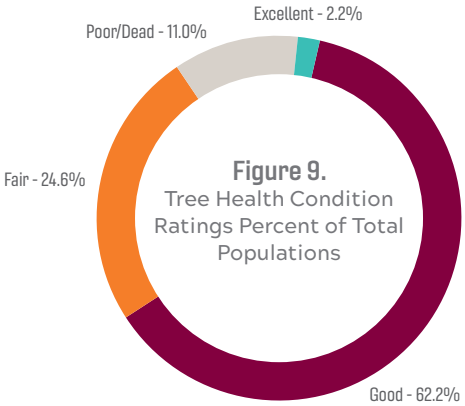


Figure 9.
Tree Health Condition Ratings Percent of Total Populations

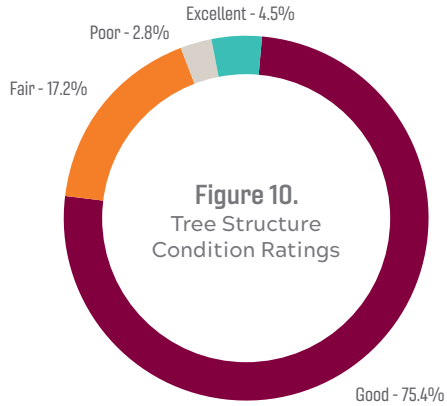


Figure 10.
Tree Structure Condition Ratings

the changing climate and stress from current and emerging pests and diseases, along with increasing educational opportunities.

Although every age group is represented in the tree inventory, the vast majority of the population—over 80%—are classified as immature (Figure 8). Young and immature trees require more frequent inspection and scheduled routine maintenance relative to the needs of mature trees. Frequent inspections to monitor tree health early in life along with prescribed pruning to encourage good structure both help maximize benefits provided by trees in their maturity, while also reducing expenses related to responsive maintenance.

The health condition ratings for trees can indicate the general health of the population. More than 25% of the trees inventoried at Virginia Tech were assessed as having fair to poor health; these trees will likely require corrective maintenance like pruning, disease treatment, or cultural practices to improve health and prevent tree decline and death (Figure 9).

Trees must have strong branching structure and sound wood conditions to withstand weather and gravity, remain low-risk, and continue to grow. A tree's structure may be influenced by site conditions, pruning practice, weather events, and various decay organisms. The majority of trees inventoried had good to fair structure when assessed (Figure 10). Routine maintenance and inspections will help ensure these trees remain structurally strong and low-risk.

Ecological and Community Values

The total value of the structural and environmental benefits provided by the trees on the Blacksburg campus was included in the 2018 inventory and analysis. The data collected as part of this project was analyzed with software developed by the United States Forest Service called i-Tree Eco. This tool models the structure of an urban forest and how trees influence the world around them. The software then analyzes the results and quantifies the environmental benefits provided by the inventoried trees to the community.

Virginia Tech's trees sequester and store enough carbon every year to offset approximately 3% of the carbon produced through total university operations (Randolph 2020, Figure 11). As trees are removed through management operations, the wood may be utilized in construction and woodcraft, continuing the storage of carbon, sometimes for many generations. These trees also slow the runoff of stormwater on campus, resulting in less severe flooding events and cleaner streams; this is especially pertinent as Stroubles Creek, a classified impaired waterway, flows through and under campus. The leaves on campus trees filter particulates and pollution from the air; this cleaner air allows the community to experience fewer respiratory health challenges.

Figure 17. Virginia Tech Urban Forest Master Plan Timeline

Carbon stored in campus trees:
4,573 tons = $566,214
When we utilize urban wood resources from campus, we store this carbon for much longer.

Carbon sequestered every year:
59.75 tons = $7,751
Campus trees and other VT forests offset university carbon emissions by ~3%

Stormwater mitigated every year:
257,072 ft^3 = $17,184
Slower runoff equals healthier campus streams

Air pollution removed every year:
2.7 tons = $6,459
Cleaner air equals a healthier Virginia Tech community

Old-Growth and Legacy Canopy

The richest ecosystem on Virginia Tech's campus is the Old-Growth Forest near Lane Stadium. This forest is a distinguishing component of the campus' identity, covers 11.3 acres, and is the remainder of a late successional white oak forest with trees over 300 years old (Seiler, 2012). The environmental benefits this rare forest provides to the Virginia Tech community are detailed in the Report on the Ecological Characteristics of the Old-Growth Forest Near Lane Stadium in 2022 (Steger and Parrott 2022).
In the summer of 2022, Grace Steger led a team of Urban Forestry interns to complete an inventory of

trees equal to or greater than 4 inches DBH. 1,711 trees were identified, mapped, measured, and conditions were assessed before input into i-Tree ECO for analysis. The resulting report shows that each year the forest sequesters 15.7 tons of carbon and attenuates 43,130 ft3 of stormwater runoff, saving the university $5,563.03 annually. Cumulative carbon storage benefits were reported to equal 1,016.51 tons at a value of $173,360.06, offsetting a significant portion of campus carbon emissions. Ecosystem services like these are dependent on the Old-Growth Forest near Lane Stadium's preservation and health; if these assets were to be replaced, the resulting expense would surpass $6.23 million. In addition to these anthropocentric services and asset values, the significant volume of dead wood including nurse logs and wildlife snags in the forest are essential to local wildlife, providing a unique urban habitat for diverse wildlife populations.

Other especially significant populations of trees include Legacy and Specimen trees, two categories that represent individuals of particularly high value. "Legacy" trees include those with exceptional size, condition, and cultural importance to the community. A total of 222 trees on campus are categorized as Legacy trees and as of May 2022 the cumulative replacement value of these is estimated at more than $8.1 million. Beyond these trees' cultural value, Legacy trees are inherently large and capture and store carbon

Replacement Value of the Blacksburg Campus Urban Forest

$30,622,817

at rates similar to the trees within the Old-Growth Forest. "Specimen" trees are those with significant intrinsic value such as historical or academic importance. There are 83 trees classified as Specimen, 56 of which are commemorative trees. The remaining trees are uncommon species, exceptionally sized non-Legacy trees, or are used for teaching by professors within the College of Natural Resources and Environment and College of Agriculture and Life Sciences.

If Virginia Tech were to replace every tree recorded in the Blacksburg Campus Tree Inventory in 2018 with the largest commonly available planting stock, the expense would amount to almost $31 million. This analysis does not account for the trees inventoried since 2018, the incremental growth since that analysis, or the generations required for trees to mature and provide the benefits the Virginia Tech community enjoys today.

An asset of this value requires continued investment in maintenance and sustainability. One way to budget for that necessity is the allocation of 2% of the asset's value, or approximately $600,000, to routine maintenance and an additional 2% of the asset's value to replacement tree planting (Stewart and Wiseman 2018).

Analysis

Natural resource management and development of a comprehensive urban forest management program are a priority.

Previous Management

ADMINISTRATION

Before October 2019, trees on Virginia Tech properties were managed by the Grounds crews from the Buildings and Grounds team in the Division of Campus Planning, Infrastructure, and Facilities.

- The division had no Urban Forest Manager.
- Maintenance occurred reactively with no master plan, tree policy, routine maintenance plan, planting plans, or industry-compliant tree care operation procedures.
- The Arboretum Committee, an interdepartmental advisory committee of professionals in natural resource and campus management, assisted division staff with technical consultation to support tree protection and mitigate imminent risks on a limited basis.
- Some sites managed trees independently; the Virginia Tech Golf Course, the Corporate Research Center, the Hahn Horticulture Garden, and Virginia Tech Athletics maintained trees as part of their operations, sometimes with support from the division.

MAINTENANCE

Historically, tree maintenance was addressed on a request basis with no dedicated resources for planning, implementing, or monitoring tree care programming.

- Most tree maintenance was performed by Grounds crews with minimal resources.
- A crew of four people worked to resolve basic tree requests and emergencies including failed trees, hanging branches, and some standing dead trees. Some maintenance pruning was completed on a reactive or request basis.
- Some plant healthcare treatments (cultural, biological, and chemical strategies to improve tree health) were assigned and completed on a limited basis.
- Tree maintenance was not scheduled or tracked in a searchable database.
- Some professional arboricultural work was contracted to professional arborists on a limited basis.

PLANTING

Various planting efforts have resulted in a patchwork of young trees with no strategic tree planting plan.

- Most trees planted on Virginia Tech properties were installed as part of the many large capital construction projects that occur across the Blacksburg campus and at other Virginia Tech properties.
- Some smaller planting projects were prepared annually by the Office of University Planning and facilitated by Grounds staff; these projects usually coincided with Earth Week and Arbor Day activities across campus.

- Grounds staff installed some trees as part of memorial programs and during landscape renovations across the central campus.
- Substantial riparian buffer plantings (stream-side mass planting of seedlings and live stakes) funded by the Green RFP Program and other grant programs, teaching demonstrations with classes from the Department of Forest Resources and Environmental Conservation at the College of Natural Resources and Environment, and specimen plantings at the Hahn Horticulture Garden have occurred.
- Species selection and site conditions were reviewed by the landscape architects in the Office of University Planning and other division professionals but plantings were not part of a strategic tree planting plan.

CONSERVATION

The Arboretum Committee and the Division of Campus Planning, Infrastructure, and Facilities have worked closely in an effort to institute best management practices that preserve Virginia Tech's urban forest resources but implementation was limited.

- There was limited use of nurse logs and wildlife snags around the Virginia-Maryland College of Veterinary Medicine facility, at the Grove, and within the Old-Growth Forest by Lane Stadium.
- Some use of coarse wood chips around the root zones of mature trees was implemented.
- A few examples of tree preservation projects across campus have successfully protected trees throughout development and construction activities.
- Without the aid of a full-time urban forest manager on staff, most of the projects did not develop into standard procedures or programming.

OUTREACH

Public education and outreach concerning urban forest management at Virginia Tech was limited.

- Tree planting events like Arbor Day and Earth Week events were coordinated by the Office of Sustainability, Office of University Planning, Site and Infrastructure Development (SID), and the Division of Campus Planning, Infrastructure, and Facilities.
- Professional arboriculture and urban forestry conferences were held on campus and hosted by professors at the College of Natural Resources and Environment.
- Volunteer days have occurred in the Old-Growth Forest by Lane Stadium; these events are led by incredibly generous volunteers and hosted by the Virginia Cooperative Extension and the Virginia Master Gardeners.

Current Resources

The Division of Campus Planning, Infrastructure, and Facilities has made natural resource management a priority and secured the following resources to begin development of a comprehensive urban forest management program:

- In October 2019, Jamie King, an ISA Board Certified Master Arborist, ISA Municipal Specialist, and Qualified Tree Risk Assessor, became the first Urban Forest Manager and University Arborist (henceforth University Arborist) in the division.
- In March 2021 the Grounds crew that regularly works with trees began reporting directly to the University Arborist and the new Urban Forest Team was created.
- In October 2021 the University Arborist hired the program's first Field Arborist, Kenneth Harmon, and the new position supervises Urban Forest Team and field operations.
- Urban forestry programming and operations are a stand-alone unit but no organization number and other formal departmental positioning has been established.
- Plan review is completed by the University Arborist but many plans are not submitted for urban forestry review.
- Urban forestry programming, including public outreach, institutional communication, tree maintenance, tree planting, tree protection, clerical duties, and other important work, has been supported by leaders, groups, and individuals across the university. This outpouring of community support is the foundation of the emerging best-in-class urban forest management program.
- A backlog of urban forest work, assessed throughout 2020, was partially funded as part of year end spending in 2020 and further investment was committed in July 2021 and July 2022 but sustainable resources for responsive and routine maintenance is still a critical need.
- The Office of University Planning and the College of Natural Resources and Environment partnered to complete a full inventory of campus trees in 2018. Eric Wiseman, PhD, and Peter Stewart, MS, analyzed the database and produced a report detailing the structure and condition of Virginia Tech's Blacksburg campus urban forest at that time. The report, "Inventory and Analysis of Landscape Trees and Urban Forests on the Main Campus of Virginia Tech in Blacksburg, Virginia," as well as the searchable inventory are available on the Virginia Tech website (Stewart and Wiseman 2018). This important and invaluable analysis and inventory provided the core of this plan and is currently used for planning maintenance and planting projects.
- Several grants have been awarded to the Urban Forest Team through the Virginia Department of Forestry Urban and Community Assistance Program including funds to treat ash trees for protection from the emerald ash borer in 2020, funds to execute a complete inventory in the Old-Growth Forest in 2022, and funds to contract the development of urban forest management plan for the Blacksburg campus in 2023.

Recommendations

Virginia Tech's urban forest is valued at almost $31 million

The approaches detailed in this plan include calculated average estimates for various strategies to achieve the goal of establishing a comprehensive urban forest management program at Virginia Tech. These estimates are conservative and do not represent the full expense related to urban forest management and programming.

Program Administration and Operations Supervision

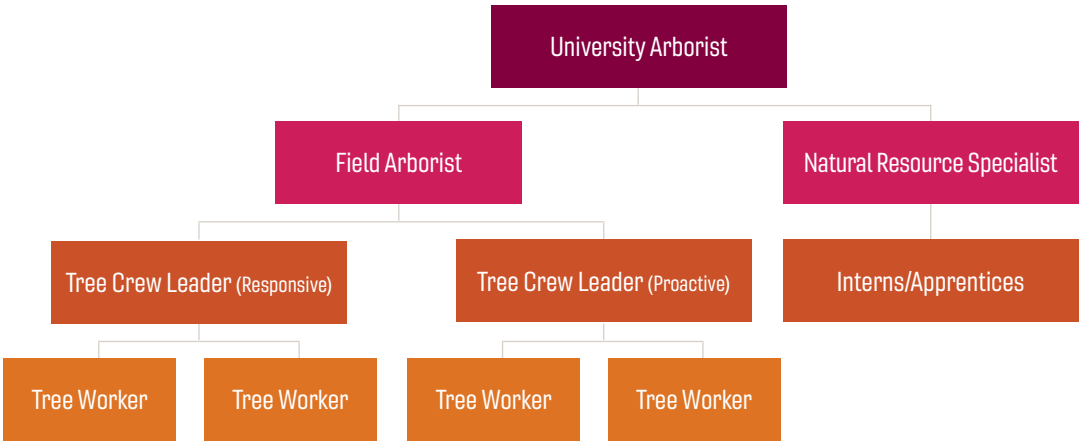
The very first step towards formalization of the urban forestry team is development of an organization number like other operational units at the university. This simple update will clarify organizational position and allow progressive development of the program to begin.

A summary listing the resources needed and strategies for success for the program administration and operations of the Virginia Tech Blacksburg Campus Urban Forest Master Plan are detailed in Table 2. Resources needed include additional personnel, plans for maintenance and tracking of assets in the urban forest, and the funding to support those plans.

Table 2. Administration and Operations Action Items

Resources	Strategies
Finalize the grant funded Urban Forest Management Plan with maintenance and planting components	Create an organization number for the urban forestry program and formalize department position.
Cultivate partnerships and pursue funding for UTC updates every 5 years and complete tree inventory updates biennially	Engage the Division of Campus Planning, Infrastructure, and Facilities leadership in final drafts of policy, standards, and procedures.
Secure funding: › to contract routine tree maintenance › to develop positions for: + Natural Resource Specialist role + 2 Tree Crew Leaders roles + 4 Tree Worker roles › for tree assessment management software	Present the Tree Policy for adoption as a division policy.
	Pursue adoption of the tree policy as a university policy
	Gain adoption of the Campus Urban Forest Master Plan by the Division of Campus Planning, Infrastructure, and Facilities.
	Ensure all campus trees are incorporated into all master or management plans.
Further engage the Arboretum Committee	Meet requirements and file for accreditation with the Society of Municipal Arborists
	Formalize the student internship program and pursue apprenticeship program development.

Figure 12. Proposed Staffing Structure for the Urban Forest Master Plan



PERSONNEL

Virginia Tech's urban forest is valued at almost $31 million (Stewart and Wiseman 2018). The long-lasting results of robust urban forestry practice have very significant implications for Virginia Tech properties and staffing levels will directly influence the management and operational capacity of the new programming.

The various tree care programs recommended in this plan require dedicated personnel with expertise in natural resources management and specifically arboriculture. The team, will work closely together while bringing additional value to other Division of Campus Planning, Infrastructure, and Facilities units like Buildings and Grounds, the Office of Sustainability, and various other partners like the College of Natural Resources and Environment and the College of Agriculture and Life Sciences.

The proposed structure in Figure 12 shows the minimum staffing necessary to respond to emergencies, continue resolving backlog maintenance, schedule routine maintenance, and provide high quality customer service. These programs are dependent on contracts with professional arborists until staffing is secured to resolve the backlog and establish routine maintenance.

UNIVERSITY FORESTRY STAFF ROLES

Field Arborist

Supervision of staff, operations, field personnel training, and tree inventory revision is critical for successful urban forest management. The Field Arborist position, classified as a Natural Resource Specialist III, fulfills these operational needs and was filled in October 2021 by Kenneth Harmon.

Natural Resource Specialist

The planning, data analysis, public outreach, and report and proposal writing associated with urban forest management are substantial. A Natural Resource Specialist, a position classified as a Natural Resource Specialist III, is necessary to assist with plan review, update operational plans, pursue grant or foundation funding, and coordinate public outreach activities. This role also provides mentorship for urban forest interns and apprentices.

Two Tree Crew Leads and Four Tree Workers

Tree maintenance is the core of urban forest management and is conducted in the field by skilled professionals. Two Tree Crew Leads and four Tree Workers, positions classified as Natural Resource Specialist II, will report to the Field Arborist and conduct tree maintenance activities including tree pruning or removal, plant health care, tree planting, and emergency response. This strategy allows one crew to respond to urgent maintenance needs and special projects while allowing another crew to focus on proactive routine maintenance.

Contracts

The job market for professional arborists is particularly challenging in southwest Virginia where salaries for entry-level Tree Workers at Virginia Tech are 23 percent less than the mean annual wage in Virginia. As tree workers refine their skills and knowledge in the public sector, it is typical for them to seek higher compensation in the utility and private sectors. These personnel challenges are compounded by a general shift in employee expectations across sectors. The private sector, particularly large firms like Bartlett Tree Experts and Davey Tree Experts, have addressed these trends with robust recruiting, training, and outreach programs (Orrick 2019). The expense of these workforce development programs has resulted in a concentration of talented arborists in the private sector, challenging public sector recruitment and retention of skilled arborists.

If the recommended staffing recommendations are not implemented, contracting routine urban forest maintenance is necessary to ensure adequate maintenance for campus tree assets. Historically, capitalizing on the private sector has been shown to enhance management flexibility, reduce institutional liability, and show up to a 37 percent reduction in expenses for urban forest maintenance in regions with competitive commercial tree care services (Warringer 2006). Large firms provide greater capacity for maintenance while smaller firms provide specialty skills and equipment.

Policy, Standards, and Procedures

The current standards and design requirements concerning Virginia Tech's trees are part of the Virginia Tech Design and Construction Standards Manual (DCSM, Virginia Tech Facilities Department 2020). The standards have been revised in conjunction with development of this plan and will be regularly reviewed and updated as needed.

Standards and Design Requirements within the Design and Construction Standards Manual

- **Tree Care Standards —** These standards serve as a source for designers, contractors, and Virginia Tech faculty and staff to reference when planning and implementing activities that may impact campus tree assets (included in the Design and Construction Standards Manual).
- **Development Tree Canopy Requirements —** These design requirements propose tree canopy thresholds for new development projects and large renovations so the campus tree canopy goal may be enforced (proposed for inclusion in the Design and Construction Standards Manual).
- **Tree Protection Standards —** These standards present practices (root pruning, soil renovation, and design protocols) to support tree protection during construction on campus (included in the Design and Construction Standards Manual).
- **Tree Planting Standards —** The standards present practices (tree diversity requirements, planting stock standards, and a two year guarantee period) to enhance tree species diversity and tree installation success on campus (included in the Design and Construction Standards Manual).

A university tree policy is required to ensure responsible tree management on Virginia Tech properties. Drafts for a proposed tree policy and various tree care and management procedures may be found in the Virginia Tech Urban Forest Foundations.

Policies and Procedures within the Virginia Tech Urban Forest Foundations

- **Tree Policy —** The proposed policy establishes a commitment to no net loss of tree assets and tree canopy on the Blacksburg campus at Virginia Tech. The policy proposes a campus tree canopy goal of 25% by 2050 and the following standards and procedures to help the university fulfill this commitment.
- **Arboricultural Contractor Standards —** These proposed standards form a rubric to compare different individuals and firms when awarding tree care contracts. Professional credentials and reputation, market value of services, and detailed job plans serve as standards that prove an arborist or contractor provides safe, skillful, and valuable services.

- **Internal Procedures —** These procedures ensure practices are standardized within the Division of Campus Planning, Infrastructure, and Facilities.
  - Urban Forest Storm and Emergency Response Procedure
  - Tree Inspection
  - Tree Risk Assessment
  - Old-Growth Forest Tree Risk Assessment Plan
  - Work Order Procedure
  - Inventory Update

The proposed tree policy, standards, and procedures form an administrative structure to urban forest management and will allow practitioners to cite compliance or deficiencies throughout management decisions.

PLANNING

Master Plan

Urban forestry programming is dependent on long term planning and this proposed Virginia Tech Blacksburg Campus Urban Forest Master Plan is an important first step. An urban forest master plan sets a scope that defines the vision, objectives, and priorities for a community's urban forest. Urban forest managers then implement outreach, planting, and maintenance programs to achieve that vision.

Specific maintenance and planting operations plans will form an urban forest management plan that guides the University Arborist office towards achieving goals established in the master plan. This management plan may be contracted to a private urban forestry consultant firm and are useful for many years.

- **Routine Maintenance Plan —** Urban tree maintenance must be planned in advance to be cost-effective. A routine maintenance plan that prioritizes high maintenance areas and trees, along with establishing a regular maintenance cycle, will assist the University Arborist office during operations. An urban forest management plan that includes a routine maintenance plan was funded by the Virginia Department of Forestry Urban and Community Forestry Assistance grant in 2022 and will be completed in 2023.
- **Campus Tree Planting Plan —** To adequately stock Virginia Tech's urban forest, a comprehensive planting plan must be developed that analyzes current available planting space, spaces likely to be available in the near future (e.g., spaces below trees that are declining or spaces around infrastructure slated for renovation or demolition), and spaces that will likely be lost to further development and construction at Virginia Tech. Assurance of a sustainable urban canopy is dependent

on the development of a centralized planting operations plan and oversight by the University Arborist office. An urban forest management plan that includes a planting plan was funded by the Virginia Department of Forestry Urban and Community Forestry Assistance grant in 2022 and will be completed in 2023.

It is important that all of the trees at the Virginia Tech Blacksburg campus be included in this comprehensive plan. The trees on sites managed independently like the Virginia Tech Golf Course, the Corporate Research Center, the Hahn Horticulture Garden, and Virginia Tech Athletics facilities have significant value and should not be neglected. This planning process will ensure cooperation between managers at all of these sites and ensure the required communication, planning, and feedback to manage the entire urban forest sustainably.

ARBORETUM ADVISORY COMMITTEE AND ACCREDITATION

Arboretum Advisory Committee

The Virginia Tech Arboretum Advisory Committee is composed of members of the Virginia Tech community and represents stakeholders from the student body, faculty, the Division of Campus Planning, Infrastructure, and Facilities, and the local community. The group has assisted with advice and consultation for decades and continues to be a valuable resource during urban forest management. A subcommittee of its members was influential throughout the development of this plan. This committee is well positioned to assist with community engagement, planting events, and accreditation while maintaining an open dialogue with natural resource professionals in the community. Further engagement of the group is recommended and more frequent meetings with detailed agendas will likely result in better stakeholder engagement and more programmatic capacity.

Tree Campus Higher Education

Virginia Tech has been recognized by the Arbor Day Foundation as a Tree Campus Higher Education (formally Tree Campus USA) since 2008. This program requires universities and colleges to meet criteria that form a foundation for urban forest and integrated natural resource management:

- **Campus Advisory Committee —** Fulfilled by the Arboretum Committee.
- **Campus Tree Care Plan —** Fulfilled up to this point by a basic document located in the Design and Construction Standards Manual. The proposed tree policy and additional standards and procedures will strengthen this commitment.
- **Campus Tree Program (with dedicated annual expenditures) —** In the past this has been fulfilled by Buildings and Grounds and documented by the Office of University Planning. Coordination of this requirement by the University Arborist began in 2020.

- **Arbor Day observance —** Most previous years this requirement was met through the Earth Week tree planting events hosted by the Office of Sustainability and supported by the Division of Campus Planning, Infrastructure, and Facilities and the Office of University Planning. Coordination of Arbor Day is now implemented by the University Arborist with support from the Arboretum Committee, Buildings and Grounds, the Office of Sustainability, the College of Natural Resources and Environment, and the Office of University Planning.
- **Service learning project —** Several tree planting, tree care, and tree educational events occur at Virginia Tech each year, hosted by various groups like the College of Natural Resources and Environment, the Office of Sustainability, and the Site and Infrastructure Development; these events have been documented by the Site and Infrastructure Development and the Office of University Planning. Oversight of some of the community and student events is now coordinated and documented by the University Arborist.

The Tree Campus Higher Education accreditation is valuable and aligns well with urban forest management at Virginia Tech. Upon completion and adoption of this plan the results should be shared with the Arbor Day Foundation as an example of programmatic growth through planning and institutional commitment.

Further Accreditation

The Society of Municipal Arborists (SMA) offers participation in a Municipal Program Accreditation program that sets a standard for urban forest program administration. Formulation of Virginia Tech's urban forest management program in line with this standard will lead to its accreditation and will set an example for other universities and municipalities.

Currently, Municipal Program Accreditation is offered to municipalities that meet programmatic requirements, one of which is recognition by the Arbor Day Foundation with a Tree City USA Growth Award. Management of urban trees in the university environment is very similar to municipal forestry—urban forestry requires the same plans, professionalism, and dedication to service—but Tree Campus Higher Education participants do not qualify for Tree City USA Growth Awards. The University Arborist coordinated with SMA and the Arbor Day Foundation in 2019 to allow Tree Campus Higher Education designees to apply for the Municipal Program Accreditation program without meeting the Tree City USA Growth Award criteria. This small change permits Virginia Tech and other universities to gain accreditation for their urban forest programs.

The University Arborist has joined the SMA accreditation committee and developed a plan to fulfill the program requirements. Fulfillment of this plan and goal is dependent on the adoption of the Urban Forest Master Plan and Tree Policy; this will allow Virginia Tech to accept the credential at the SMA Conference after accreditation is awarded. Virginia Tech's recognition as the first accredited university urban forestry program will set an example for other institutions and add significantly to Virginia Tech's sustainability credentials.

TREE ASSET ASSESSMENT PROTOCOL

Up-to-date urban tree canopy (UTC) and tree inventory data is essential when managing urban forest assets.

The UTC data cited for this plan was provided by research performed by the College of Natural Resources and Environment and was critical throughout its development. Reassessment of the Virginia Tech UTC is necessary on a scheduled cycle of at least every five years; this schedule allows the urban forest manager to track canopy growth or decline, impervious surface expansion, and campus development allowing adjustment of plans and programming accordingly. Partnership with the College of Natural Resources and Environment and the Virginia Department of Forestry may provide this data, but funds may be necessary to purchase assessments when research projects and statewide initiatives may not provide data on a reliable basis.

Virginia Tech's Blacksburg Campus Tree Inventory was completed in 2018 and is continuously growing. This resource is essential for planning, management, education, and outreach. Inventories require ongoing maintenance to remain relevant and valuable for operations. As campus trees are maintained through normal operations, the University Arborist office updates tree status and other attributes but further updates require in-depth assessment. This more complete data provides the inventory with more details and measurements for analysis with i-Tree or other resource analysis software. A complete update to the tree inventory including attributes used for i-Tree analysis should be scheduled biennially and may be performed by students, interns, or apprentices, along with the assistance of urban forestry staff.

TREE ASSET MANAGEMENT SYSTEM

Currently, the Blacksburg Campus Tree Inventory is housed in an ESRI Collector app. The campus tree inventory collector map, accessed through this app, was developed for the collection of inventory data and is not well suited for asset management. Urban tree management software is available that provides a user-friendly GIS map format. Each tree in the inventory is accessible through the user interface and work orders or work logs are accessible instantly in the field or office. Software like Tree Plotter (provided by Plan-It Geo) and TreeKeeper (provided by Davey Tree Expert Company), is essential for a strong maintenance program. This software requires a yearly subscription of less than $2,000, dependent on options, and will provide value to the Division of Campus Planning, Infrastructure, and Facilities through efficient management of resources.

WORKFORCE DEVELOPMENT

The urban forestry profession has an apparent deficiency in entry-level positions (O'Herrin et al. 2018b). Virginia Tech can address this deficiency while attracting talent to add capacity to the urban forest management program. The University Arborist will work directly with the College of Natural Resources and Environment and other partners to identify potential candidates for internships within the Division of Campus Planning, Infrastructure, and Facilities urban forest management program. Interns will apply for the position

and the most promising candidates will spend the season earning a fair wage, expanding and updating the inventory, learning arboriculture techniques along with management and conservation philosophy, and gaining hands-on experience in the industry.

Currently, the campus tree inventory is limited to the Blacksburg campus and other sections of campus require assessment. The field identification, measurement, and assessment of trees gives interns and apprentices a foundational skill in natural resources that is valuable in many sectors. This inventory expansion work and ongoing updates are examples of entry level work that is well suited for seasonal student interns and apprentices.

Maintenance

BACKLOG ASSESSMENT AND RESPONSE

The current level of urban forest maintenance at the Virginia Tech Blacksburg campus has mitigated many immediate risks and a favorable climate and some fair site conditions have provided an attractive campus. Nevertheless, the deferment of structural pruning and tree preservation practices that encourage good tree structure and health (i.e. routine maintenance) has saddled the university with a backlog of tree maintenance that must be addressed as a routine maintenance cycle is developed.

As of November 2018 (when the first tree inventory and analysis was completed), nearly a quarter of the tree population at Virginia Tech's Blacksburg campus were in need of corrective maintenance; this recommendation includes pruning, healthcare treatments, and removals. This is a conservative estimate, as the arborist performing these assessments was not an ISA Qualified Tree Risk Assessor and set a very conservative threshold for maintenance recommendations (Stewart and Wiseman 2018). The backlog of needed maintenance is likely larger than the reported 22% and these trees may pose some risk to the Virginia Tech community.

To begin addressing this backlog, the University Arborist began the assessment of trees with maintenance needs during the winter of 2019. This analysis resulted in a log of work for the Urban Forest Team and a critical needs budget request for contracting professional arborists to resolve other issues. This backlog reduction plan was developed in 2020 and the details and estimated expenses are included below.

More than 833 backlog orders were filed in 2020 and the University Arborist obtained estimates to complete the work. On Oct. 30, 2020, 68 orders were classified as critical (requiring immediate attention and estimated to cost a total of $65,226), 103 orders were classified as urgent and important (requiring attention as soon as is practical and estimated to cost $80,491), and 662 were classified as important (requiring attention ahead of routine maintenance and estimated to cost $153,490). Completion of this work was estimated to require $299,207 in labor by local commercial arborists but over many seasons priorities evolved and the backlog reduction plan was revised resulting in more jobs and greater expenses. The majority of the trees and issues identified in the backlog reduction plan have been resolved since 2021 with funding each year from critical needs requests.

This backlog reduction programming does not account for the burden of untrained trees, the trees requiring structural pruning to develop sound architecture, in the population. Many of the trees that have not been trained with structural pruning may have significant defects that will result in shorter lives and lower values. Addressing these trees over the long term requires more in-depth study as part of the development of the Urban Forest Management Plan.

SERVICE REQUESTS, EMERGENCY RESPONSE, AND EMPLOYEE TRAINING

Historically, Grounds staff has done well responding to emergency tree service requests, but responsive maintenance pruning to provide clearance for pedestrians, vehicles, signs, or buildings, or to improve line of sight and mitigate other conflicts often takes precedence over structural pruning, the necessary pruning practice that encourages strong branch architecture and routine maintenance that prevents the need for expensive responsive operations.

Currently, the Field Arborist and Urban Forest Team resolves some simple pruning jobs, most standing dead tree removals, emergency response, and some disease and pest treatments after assessment and direction by the University Arborist. Timely completion or work orders remains a challenge for the understaffed and under resourced Urban Forest Team.

Historically, service requests involving technical removals and some complex pruning work were contracted to private arborists and funded by Grounds at an average of $35,904 each calendar year since 2010. Since 2019, the University Arborist has prioritized critical service requests and some funds have been allocated to resolve immediate risks and other priorities through critical needs requests.

A proactive safety and skills training program to train the Urban Forest Team in professional arboriculture techniques and meet ANSI Z133 safety standards has begun under the leadership of the new Field Arborist. This required training will increase employee and public safety and improve the crew's skills when performing arboriculture work while meeting industry standards. In addition to continuous training for the Urban Forest Team, analysis for the training needs for Grounds staff that participate in urban forest storm and emergency response on campus is underway with a goal of reducing risk to personnel through cross training.

ROUTINE TREE MAINTENANCE ESTABLISHMENT

Constructed assets like academic halls, residences, and athletic facilities at Virginia Tech have been thoughtfully designed and proactively maintained to provide the benefits the community deserves. The growing assets of the Virginia Tech Blacksburg campus, including the urban tree canopy, require equally thoughtful planning and proactive maintenance.

Routine maintenance is often the goal of urban forestry management programs but fiscal constraints, compounded by popular misconceptions regarding trees and the level of maintenance required to sustain their benefits and public safety, often prevent the practice. Paradoxically, the deferment of routine urban forestry maintenance diminishes the value of public trees while increasing expenses related to responsive maintenance (Vogt 2015).

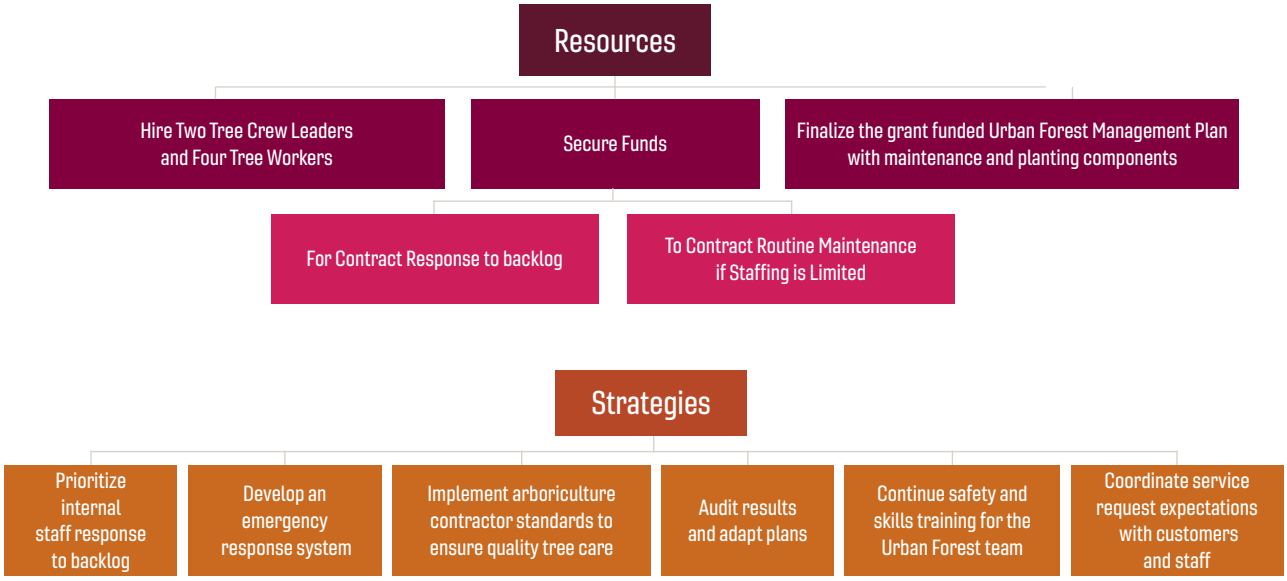
Trees growing in urban environments require regular inspection and maintenance to ensure public safety, strong tree structure, and good tree health. Structural pruning is a practice that encourages strong branch architecture for young and immature trees and is essential to ensure a safe, resilient, and sustainable urban forest. This important pruning practice has not been planned, budgeted, or implemented for the vast majority of trees on Virginia Tech properties.

Urban tree maintenance must be planned in advance to be cost-effective. The Urban Forest Management Plan will include a routine maintenance plan that prioritizes high maintenance areas and trees will aid the University Arborist office during operations.

Routine maintenance is optimized when conducted on a four or five year cycle (Miller and Sylvester 1981). Young, immature, and very overmature trees require more frequent maintenance and should be placed on the four year cycle. Mature trees may be maintained less often; a five year cycle may be sufficient. The total structural value of the trees currently in the Campus Tree Inventory is almost $31 million. When budgeting for this routine maintenance, we can use an estimate of two percent of the asset replacement value of more than $600,000 (Stewart and Wiseman 2018). This asset replacement value helps illustrate the expense required to establish a routine maintenance cycle that budgets the resources required to structurally pruning young to immature trees, maintain larger tree, and respond to over mature trees as they age. For the inventory in 2018, 8,911 trees at $30,622,817 asset value, this approach yields an estimate of $612,456.34 to maintain about 2,500 trees each year. This estimate is likely to escalate as time passes and the inventory grows larger.

Following the recommendations in this plan will provide the urban forestry program with staff to approach routine maintenance in addition to other programming. If that staff is not recruited, trained, and retained, the university must rely on qualified commercial arborists with the capacity to fulfill a contract of this scope until staffing levels are adequate to schedule the work internally. Arboriculture is practiced by professionals who specialize in the skill and science of tree cultivation and preservation. Various credentials are provided by professional organizations in the arboriculture industry that can be used to compare different individuals and firms when awarding contracts. These credentials, the market value of services, professional reputation, and detailed job plans may serve as standards that prove an arborist or contractor provides low risk, professional, and valuable services. The University Arborist has developed a set of standards to consider when reviewing estimates from consulting and contract arborists. The

Figure 13. Maintenance Action Items



resulting standards should inform the development of a standard request for proposal approved by Virginia Tech. Bids will then be analyzed for skills, professionalism, and the ability to provide cost-effective results. The maintenance resources needed and response strategies are listed in Figure 13.

Tree Replacement and Canopy Expansion Planning

TREE PLANTING

Urban forest management requires tree planting to sustain the urban canopy. Trees in the landscape are removed for various reasons: natural death, development, stress from construction activities, risk mitigation, and storm damage are the most common reasons for tree removal. In the time since the first tree inventory was completed in 2011 and the most recent analysis in 2018, 1,511 trees were removed from Virginia Tech's Core Campus (Stewart and Wiseman 2018). Despite various groups and capital construction projects planting trees, the urban tree canopy diminished.

The proposed Tree Planting Standards and Tree Canopy Requirements will ensure more trees are planted during development and construction projects and successfully established on Virginia Tech's Blacksburg campus. These two components of the Tree Policy are essential for successful tree planting programming

and must be administered by qualified urban forestry professionals. Proper tree selection during development and planting operations is important to assure specimens are well suited for the various potential planting sites at Virginia Tech and support a resilient urban canopy.

Tree planting on campus must be planned in advance to be cost-effective. The Urban Forest Management Plan will include a planting plan that prioritizes districts and individual sites with relatively low canopy while accounting for planned development and renovation. This plan will account for adequately stocking Virginia Tech's urban forest and will guide the University Arborist, the Field Arborist, and the Natural Resource Specialist when coordinating, implementing, and reviewing planting operations.

In addition to the plan, a planting budget must be established that funds the installation of at least 10% to 15% more trees than are removed every year. This minimal amount will account for mortality of newly installed trees (Stewart and Wiseman 2018). Large field-grown trees are the typical planting stock at Virginia Tech and may be sourced and installed for an average of $600. If the Division of Campus Planning, Infrastructure, and Facilities can install trees as part of a coordinated campus tree replacement program, a budget ranging from $142,800 (238 trees) to $149,400 (249 trees) must be established. Further tree planting is required to expand the urban canopy. To reach the 25% urban canopy goal listed in the proposed Tree Policy by 2050, more than 750 trees must be planted every year. Funding for this canopy expansion planting should be budgeted over time to ensure adequate tree canopy at Virginia Tech.

One way to conceptualize UTC expansion is by considering acreage across the campus. Planting 108 acres, only 39% of the total plantable space on campus, will accomplish the proposed 25% UTC for the Blacksburg campus. Establishing an interim goal can help visualize the steps necessary to reach this overall goal; a proposed interim goal may be a UTC growth of 5% over five years. The benefits of this incremental benchmark may be compounded by targeting districts with relatively low UTC and relatively high impervious surface and community gathering places.

The Athletic and Recreation district has the lowest UTC, 4.5%, and a minimum of 26.5 plantable acres. While the land use for the Athletic and Recreation district requires open space like sports facilities, recreation fields, and parking, there remains a significant opportunity for canopy expansion at the sites identified as plantable space while maintaining those important land uses. Another district with notably low UTC, 8.5%, is the Northeast and Upper Quad where a small area, 2.8 acres, is plantable. Nearby in the North Academic district, there are ten plantable acres that may be targeted to expedite UTC growth in a district with particularly dense community presence. The Creativity and Innovation, Student Life, and Life Sciences districts have a total of 28.9 plantable acres where new trees will be directly adjacent to community activities, class and lab work, dining, student housing, and office spaces. Focusing initial planting efforts towards an interim goal like 5% growth in five years that identifies priorities for UTC growth will double the canopy cover in districts like Northeast and Upper Quad while enhancing benefits at sites with high population densities.

Currently, the Office of University Planning and the Office of Gift Planning operate a commemorative tree program. This program allows members of the community to have a tree planted and a plaque installed to commemorate a person, group, or event. Coordination of the tree purchase, install, and maintenance is implemented by the University Arborist, but the funds raised through this program are controlled by the university architect. This program should be managed by the University Arborist who will coordinate with the Office of Gift Planning. This small change will allow the University Arborist to engage with the community and ensure that trees are selected and planted while funds are utilized for tree maintenance.

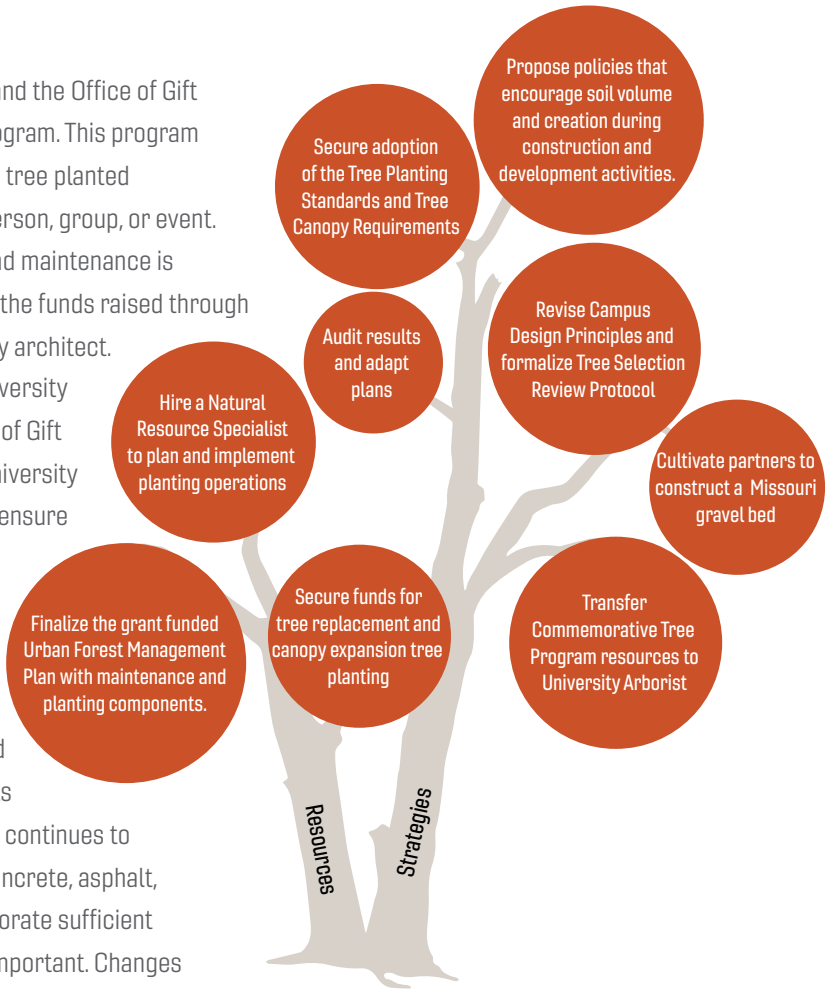


Figure 14. Planting Action Items

In addition to conventional planting spaces, policies should be developed requiring the installation of infrastructure, e.g., suspended pavement, during capital investment projects and below new parking lots. As Virginia Tech continues to grow and the landscape is hardened with concrete, asphalt, stone, etc., engineered solutions that incorporate sufficient soil volume to sustain tree life will be very important. Changes to the design standards to require the consideration of engineered soil volume solutions will ensure that designers provide adequate space to sustain the campus urban canopy while providing examples of these important systems at sites across Virginia Tech's living learning lab.

Conservation

Virginia Tech is home to many notable tree specimens and several old growth forests. Trees and forests of great ecological, historical, and community significance require conservation efforts to ensure their short term survival and long term conservation; this is especially vital in challenging urban conditions and during construction activities. The urban heat island effect, compacted soils, and mechanical damage resulting from proximity to dense development on Virginia Tech properties can further stress mature trees and that stress is compounded by climate change. If the conditions are left unmitigated, these negative effects can lead to tree death and forest loss.

TREE AND FOREST PROTECTION

Some efforts to preserve large trees across the central campus have been prioritized with support from faculty partners and the Arboretum Committee. Cultural practices such as wood chip mulching the majority of a tree's root zone, installation of lightning protection systems and structural support systems (e.g., cables or braces), leaving nurse logs or snags in appropriate spaces after tree removal, and limiting vehicle and pedestrian traffic over sensitive root zones are important steps to protecting Virginia Tech's trees. These practices will be coordinated by the University Arborist as part of tree preservation programming. Resources and strategies for tree protection are listed in Table 3.

The Virginia Tech the Design and Construction Standards Manual requires that trees be protected during construction and provides specifications and details for tree protection zones (as does the Virginia Erosion and Sediment Control Handbook for soil disturbances). These standards were outdated and have been revised with current tree protection best management practices in the proposed Tree Protection Standards. Adoption of these standards is essential to successfully preserve trees and conserve the urban forest at Virginia Tech.

Table 3. Tree and Forest Protection Action Items

Resources
Hire a Natural Resource Specialist to supervise conservation programming
Strategies
Adopt Tree Policy
Secure adoption of the Tree Protection Standards
Implement forest stewardship plans
Implement the Old Growth Forest Risk Assessment Plan
Support post and chain fencing installation around trees
Implement mulch and soil restoration programming
Develop an urban wood utilization program

While there are examples of tree protection preventing the loss of trees directly after construction activities, significant effort and resources should be allocated to identify trees for preservation, establish tree protection plans, and monitor tree protection throughout construction projects and in the years after project completion. When small trees cannot be protected, the feasibility of transplant with a large tree spade under the direction of the University Arborist office should be assessed. If some trees cannot be preserved or transplanted, funds equal to the value of the lost tree asset should be allocated for replacement on-site or elsewhere on Virginia Tech properties to sustain the urban canopy. Specific policies shall be instituted that require these preservation and mitigation practices during development on Virginia Tech properties and enforcement shall be supported by university leadership.

Virginia Tech has several large forests, including the Old-Growth Forest near Lane Stadium, the forest known as Dairy Barn Woods, and the larger forest called Center Woods, located across US Route 460 from

the core campus. These forests provide exceptional environmental services, recreation and research opportunities, cultural and historical values, economic value, and may facilitate public engagement in urban forestry conservation. The University Arborist and the Natural Resource Specialist will engage the different stakeholders with interests in these forests and continue the important work needed to conserve the resources. Some of the potential partners with interest in the management of mature forests at Virginia Tech include the Virginia Department of Forestry, the Virginia Chapter of the American Chestnut Foundation, the CNRE, the stormwater professionals at the Site and Infrastructure Development, the Office of Sustainability, Master Naturalist groups, and Save Stadium Woods.

Priority goals outlined in the "Stewardship Plan for Virginia Tech's Old-Growth Forest near Lane Stadium" include: invasive species control, establishment of formal boardwalks to dissuade the expansion of informal trails, stormwater control improvements to limit runoff, and tree planting to supplement regeneration. Many other priorities and goals are detailed in the plan; it is an excellent resource when considering forest management at Virginia Tech and guides the University Arborist as priorities are established and strategies are developed (Walters 2016). In 2022, Grace Steger led a team to complete a complete inventory of trees four inches DBH (diameter at breast height) and larger within the Old-Growth Forest and performed an ecological assessment. The results of this inventory and assessment were published in the "Report on the Ecological Characteristics of the Old-Growth Forest Near Lane Stadium" adding critical details and context to the recommendations published in the previously mentioned "Stewardship Plan for Virginia Tech's Old-Growth Forest near Lane Stadium." The University Arborist developed the Old-Growth Forest Tree Risk Assessment Plan in 2021 and implementation of assessments and risk mitigation is underway. This plan prioritizes public safety and tree preservation through routine inspections and prescribed arboricultural practices that help reduce risk and reduce the likelihood of tree and tree branch failure. These three resources form the foundation for comprehensive management that cultivates public awareness of the resource and actionable plans for stewardship and preservation in the Old-Growth Forest that may be applicable to the other larger forests.

An approach to protect historic and otherwise notable trees at Virginia Tech is to add a subinventory to the Blacksburg Campus Tree Inventory that maps and designates trees for targeted tree or forest preservation projects and protection programs. In 2022, work began to identify Legacy Trees on the Blacksburg campus and more than 200 trees of sufficient size, condition, and cultural importance were identified. These assets are mapped within the tree inventory to help plan and execute maintenance and preservation programming. The map is available for reference throughout campus planning, construction, and development so sensitive trees and sites may be prioritized and avoided. When these Legacy Trees are threatened by development and construction, the draft Tree Policy may guide decision makers through accounting for the tree's contribution to the Virginia Tech community and how best to preserve the asset or approximate its replacement value.

Soil compaction resulting from vehicle and pedestrian traffic is a major factor contributing to tree stress and mortality at Virginia Tech. The Division of Campus Planning, Infrastructure, and Facilities is developing a plan for post and chain fencing across campus, this will help mitigate the threat from vehicles and pedestrian damage on some tree root zones but will not protect all vulnerable trees. Further soil protection like systematic mulching and soil restoration programming is necessary to reverse the existing soil damage and the Field Arborist will coordinate this work.

There has been some effort to develop an urban wood reutilization program that recycles wood from campus trees for use in woodcrafts, but currently, wood is either disposed of or used as wood chip mulch. Craftspeople using wood from urban trees show a significant market opportunity to raise funds for developing this urban forest management program and wood products are well received by the public as part of sustainability efforts. One approach to develop an urban wood utilization program is to pursue a memorandum of understanding (MOU) with a local sawmill to begin to use the valuable wood from campus trees. Support from the Virginia Urban Wood Group is available and the Virginia Department of Forestry has experts to support this work.

Community Outreach

Urban forest management is a public service and education and outreach are essential when developing and implementing urban forestry programing. Trees are long-lived, valuable natural resources that are critical components of the urban environment and interface with the community in many ways. Developing a greater appreciation for trees and an engagement in supporting the urban forest requires continuous, professional communication with the public. Engaging stakeholders throughout the planning and implementation processes while developing this program will lead to stronger partnerships with community groups, faculty, and the media. Investing in these relationships, in the beginning, will facilitate open dialogue and maintain transparency. Community outreach action items are listed in Table 4.

Table 4. Community Outreach Action Items

Resources
Hire a Natural Resource Specialist to supervise conservation programming
Further engage the Arboretum Committee
Strategies
Schedule feedback sessions with community stakeholders
Develop a tree stewardship program
Plan and schedule educational events

VOLUNTEERS AND CITIZEN SCIENTISTS

Many communities have volunteer groups and citizen scientists dedicated to the promotion and protection of the urban forest. Volunteers work to prune or plant young trees, educate the public, and participate in other activities that support urban forest management. These groups of

stewards are often organized, educated, and coordinated by natural resource professionals in the urban forestry field. Virginia Department of Forestry supports many of these groups with a standardized Tree Steward curriculum, networking opportunities, scholarships for continued education, and mini-grants. The University Arborist will work with the Natural Resource Specialist to develop a tree stewardship program at Virginia Tech that gives members of the community opportunities to support the urban forest while learning more about trees and engaging with their community.

COMMUNITY ENGAGEMENT

As the University Arborist begins to implement the various programming recommended in this plan, communication with the Virginia Tech community is important to build and sustain support. One approach to facilitate communication is to host tree tours and walks, educational presentations, and volunteer days. These opportunities help educate the public about urban forest management while giving citizens opportunities to share feedback with the urban forest manager. The University Arborist will work with the Natural Resource Specialist to develop a community engagement plan that schedules different educational events for the public.

Management Expense Comparisons

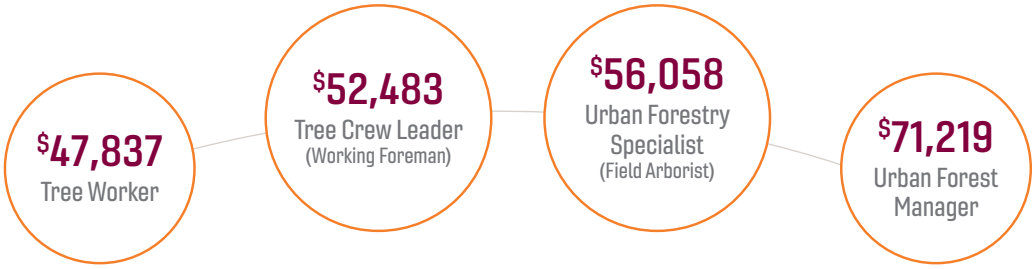
MUNICIPAL FORESTRY COMPARISON

The management of the urban forest at Virginia Tech is closely aligned with the municipal forestry profession. A 2014 municipal tree care and management census from 667 communities nationwide (Hauer and Peterson 2016) is the source for the following budget estimates for the Virginia Tech Urban Forest Master Plan. Estimates from this census should be considered lower limits for budgeting as prices for goods and services generally do not remain static in any field, but will increase over time. In addition to the escalation of expenses for the current urban forest on campus, growth of the UTC at Virginia Tech as detailed in this plan will require a budget on similar scale.

Tree management activities (planting, pruning, pest management, removal, etc.) for all municipalities averaged $42.59 per street tree in 2014. Using this average to calculate an estimate for the 11,500 trees on the Virginia Tech Blacksburg campus leads to an annual budget of approximately $489,785.

The average forestry budget per capita for municipalities with populations between 25,000 and 500,000 in 2014 was $9.40. Student enrollment for fall 2022 was tallied at more than 37,000 and Virginia Tech employs over 13,000 faculty and staff. Using a total of 50,000 people and the average forestry budget per capita from the 2014 census, a forestry budget of approximately $470,000 can be calculated.

Figure 15. Average Salaries from 2014 Municipal Census



The municipal census provided average salaries for employees maintaining the urban forests (Figure 15) and these can also be used as a guide while estimating the Virginia Tech Blacksburg campus forestry budget. (Figure 16)

Multiplying the average annual expense per tree ($46.25) to the population of trees on the Virginia Tech Blacksburg campus (11,500) would yield an annual total tree care budget of $531,875.

TREE CAMPUS HIGHER EDUCATION COMPARISON

The University Arborist and intern Madeline Bryant requested Tree Campus Higher Education application submittal data from the Arbor Day Foundation (ADF) in 2023. The ADF provided data from the 14 years of the Tree Campus program for all participating land grant institutions and Virginia Tech's SCHEV (State Council of Higher Education for Virginia) peer institutions. The data included total expenditures for urban forestry management and student populations for each year of participation in the program. (Table 6).

Figure 16. Sample Adjusted to 2022 Average Annual Expense per Tree for Locations with a Similar Climate

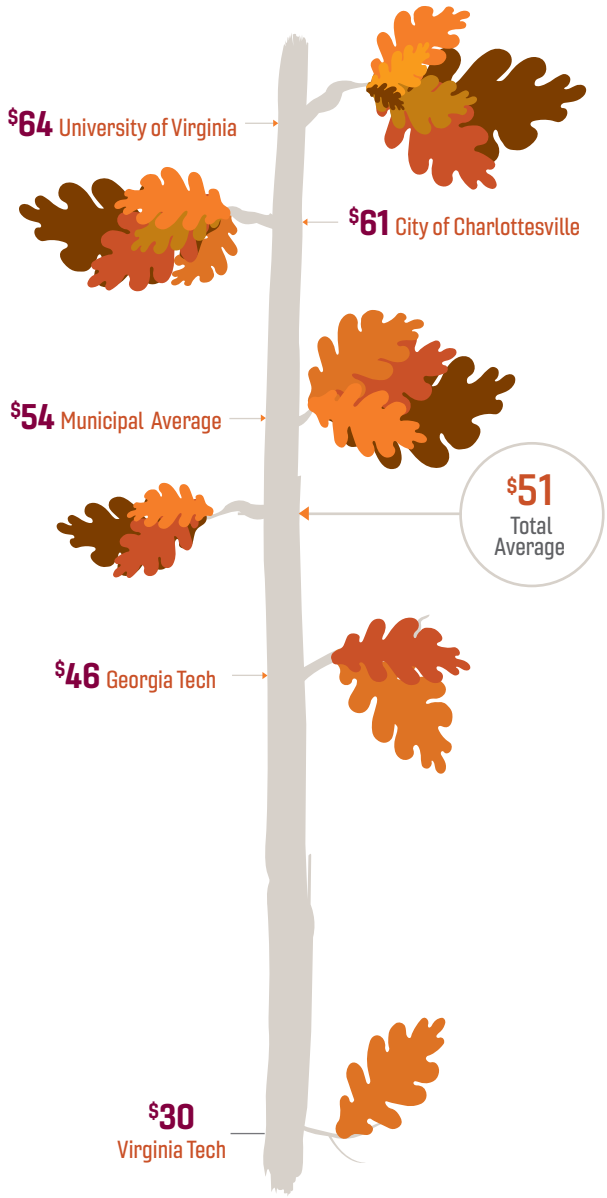


Table 6. Average yearly total and per capita urban forestry expenditures at SCHEV Approved Peer Institutions and Land Grant Institutions compared to Virginia Tech's average urban forestry expenses 2008 - 2022. All data reported as part of Arbor Day Tree Campus application requirements.

Tree Campus Higher Ed. Institutions	Total Expenditures	Total Per Capita Expenditures
SCHEV Peer Institutions	$403,289	$9.23
Land Grant Institutions	$392,459	$9.50
Virginia Tech	$135,072	$4.16

Virginia Tech invests > $250,000 less in urban forestry than peer institutions.

PROPOSED BUDGET

A conservative estimate of annual expenditures for developing a comprehensive urban forest management program at Virginia Tech is presented in Table 5.

Table 5. Proposed Virginia Tech Urban Forest Management Program Budget

Item	Annual Expenditure
Administration	
Field Arborist Salary	$56,000
Natural Resource Specialist Salary	$56,000
Tree Asset Management Software	$2,000
Maintenance	
(2) Tree Crew Lead and (4) Tree Worker Salary	$ 296,315
Routine Maintenance Contract (If staffing is inadequate)	$465,000
Tree Replacement	$149,000
Projected Annual Base Budget Total	**$559,715** Staffed as recommended –or– **$752,400** Relying on Routine Maintenance Contract

Average expense estimates for tree care fluctuate greatly due to the highly variable nature of tree size, location, condition, and other site and tree variables. As trees grow, deferred maintenance compounds tree problems and may ultimately result in the loss of tree assets. These estimates are conservative and do not represent the full expense of comprehensive urban forest maintenance programming.

There are several potential funding sources for the Virginia Tech Blacksburg campus forestry budget. The primary source for the budget would come from the Division of Campus Planning, Infrastructure, and Facilities and critical needs requests with strategic budgeting towards development of this program are filed annually. Several investments through critical needs requests have been applied to reduce the urban forest maintenance backlog since 2020 but funds for staff and equipment have not been allocated.

Programs and grants may be able to supplement the forestry budget

- National Urban and Community Forestry Assistance grants and Virginia Department of Forestry cost share programs
- Commemorative tree program fees and donations
- Profits from campus wood utilization programming
- Arbor Day Foundation grants
- Sponsors and donors
- Partnerships

Path to Success

The success of this plan is dependent on outreach, engagement, and inclusion with the Virginia Tech community.

Recommendations Summary

MANAGEMENT AND ASSESSMENT

1. Formalize the urban forestry program by creating an organization number and formalize departmental positioning.
2. Adopt the Virginia Tech Blacksburg Campus Urban Forest Master Plan.
3. Secure funding for the Virginia Tech Blacksburg Campus Urban Forest Master Plan.
4. Adopt the Virginia Tech Tree Policy and Urban Tree Canopy Goal.
5. Hire a natural resource specialist, tree crew leaders, and four tree workers.
6. Continue resource assessments — UTC analysis every five years and complete tree inventory update biennially.
7. Invest in tree asset management software.
8. Continue commitment to remain an Arbor Day Tree Campus Higher Education USA.
9. Gain accreditation from the Society of Municipal Arborists (SMA) as an SMA Accredited Urban and Community Forestry Program.
10. Develop internship and apprenticeship programming.

ENGAGE AND PLAN

1. Schedule feedback meetings with community stakeholders.
2. Cultivate support and capacity within the Arboretum Committee.
3. Implement forest stewardship plans.
4. Execute the newly developed Urban Forest Management Plan (due for completion in 2023).
5. Plan and schedule educational events for faculty, staff, and the public.
6. Develop a community tree stewardship program.

MAINTAIN

1. Institute a tree emergency response system.
2. Resolve the tree maintenance backlog.
3. Staff appropriately or develop a contract to fulfill routine tree maintenance on campus.
4. Continue safety and skills training for the Urban Forest Team.

PLANT, PROTECT, AND CONSERVE

1. Establish comprehensive tree asset replacement.
2. Pursue tree canopy expansion tree planting programming.
3. Institute enhanced tree protection and preservation programming.
4. Utilize the Legacy Tree Inventory during planning and operations.
5. Implement systematic plant health care programming.
6. Develop an urban wood utilization program.

MONITOR AND ADAPT

1. Audit programming results on a monthly schedule.
2. Assess personnel performance and achievements quarterly.
3. Share management results with community stakeholders quarterly.
4. Update and revise operational plans annually.
5. Update and revise the urban forest master plan every five years.

Priorities

LEADERSHIP

The Division of Campus Planning, Infrastructure and Facilities has made natural resource conservation a priority and began development of a comprehensive urban forest management program in the autumn of 2019. University Arborist Jamie King initiated the concept of this urban forest master plan with support from the Vice President of Campus Planning, Infrastructure, and Facilities Chris Kiwus, PE PhD, the Assistant Vice President for Facilities Operations Wendy Halsey, PE, and the Deputy to the Assistant Vice President for Facilities Operations Anthony Watson. Throughout the analysis and preparation of this plan, input and guidance by the Arboretum Committee was indispensable. This team must unite in support of Virginia Tech's urban forest vision and present this plan to university leadership for adoption as part of the Campus Master Plan so resources and authority may be allocated to fulfill the recommendations mapped in this plan.

ENGAGEMENT

The success of this plan is dependent on outreach, engagement, and inclusion with the Virginia Tech community. An engagement strategy that begins with scheduled feedback meetings, continued outreach throughout plan implementation, and includes stakeholders in the plan revision process is imperative as Virginia Tech strives to reach its urban forest vision. Application of this outreach work must begin as soon as this plan is finalized in order to include community feedback in management strategies during program development.

IMPLEMENTATION

Natural resource management is in the public's interest and urban forest management at Virginia Tech provides exceptional cultural, ecological, and economic benefits to the local community and the public. This plan recommends a programmatic approach that will maximize Virginia Tech's return on investment in campus natural resources, improve public health, community productivity, ecological quality, and campus livability. Implementation of the recommended programs requires the commitment of resources and specialized natural resource professionals, otherwise, Virginia Tech's urban forest vision will not be realized. While resources for urban forest management may be gained from grants, sponsors, and partnerships, it is necessary that the Division of Campus Planning, Infrastructure, and Facilities allocate appropriate resources to begin this work as soon as is practical.

EVALUATION AND ADAPTATION

Continuous monitoring allows adaptive management to capitalize on opportunities while avoiding conflicts and uncertainties. Structured tree asset assessments like the UTC and tree inventory updates monitor the status and health of the urban forest so the urban forest master plan, urban forest management plan, and the combination of policy, procedures, and standards may be adapted to maximize efficiency and ensure strategies are on track to meet benchmarks and goals. The data from these assessments are useful and illustrative when pursuing input and feedback from community stakeholders and university leadership. Commitment to this assessment strategy and engagement protocol will maintain transparency and facilitate an inclusive management approach while allowing the University Arborist to adapt programming to meet the community's expectations.

SCHEDULE FOR SUCCESS

The timeline in Figure 17 illustrates an optimistic four-year schedule. This plan was envisioned during the fall of calendar year 2019 and developed over the winter and spring of calendar year 2020. To move forward, resources must be allocated for fiscal year 2024 so programming may be developed and instituted throughout the calendar year 2023 and onward. Urban forestry maintenance backlogs, planning deficiencies, and programming challenges compound over time as trees grow and communities change. Swift and decisive action to commit to this plan will ensure Virginia Tech's urban forest vision is realized.

Figure 17. Virginia Tech Urban Forest Master Plan Timeline

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Swift and decisive action to commit to this plan will ensure Virginia Tech's urban forest vision is realized.

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Tree Terms Glossary

Arboriculture
The science and art of caring for trees at natural and managed sites.

Arborist
A person possessing the technical competence through experience and related training to provide for or supervise the management of trees at natural or managed sites.

Compaction
The compression of soil, causing a reduction of pore space and an increase in the density of the soil. Tree roots cannot grow in compacted soil.

Critical root zone
Portion of the root system that is the minimum necessary to maintain vitality or stability of the tree. Encroachment or damage to the critical root zone will put the tree at risk of failure.

Fertilization
The process of adding nutrients to a tree or plant; usually done by incorporating the nutrients into the soil, but sometimes by foliar application or injection directly into living tissues.

Landscape
Areas of land that are distinguished by differences in landforms, vegetation, land use, and aesthetic characteristics.

Mitigation
Action taken to alleviate potential adverse effects on wetlands and fish habitat undergoing modification. Also commonly used to mean compensation for damage done.

Mulch
Any material such as wood chips, straw, sawdust, leaves, and stone that is spread on the surface of the soil to protect the soil and plant roots from the effects of raindrops, soil crusting, freezing, and evaporation.

Pruning
Selective removal of woody plant parts of any size, using saws, pruners, clippers, or other pruning tools.

Root System
The portion of the tree containing the root organs, including buttress roots, transport roots, and fine absorbing roots; all underground parts of the tree.

Root Zone
The area and volume of soil around the tree in which roots are normally found. May extend to three or more times the branch spread of the tree, or several times the height of the tree.

Soil
A dynamic natural body composed of mineral and organic materials and living forms in which plants grow.

Species
The main category of taxonomic classification into which living organisms are subdivided, comprising a group of similar individuals having a number of correlated characteristics.

Stress
Unfavorable deviation from normal. The action on a body of any system of balanced forces whereby strain or deformation results. In arboriculture, the adverse alteration of tree health by abiotic or biotic factors.

Thinning
Pruning technique in which branches are removed at their point of origin.

Tree protection zone
A designated area around trees where maximum protection and preservation efforts are implemented to minimize soil compaction, etc.

Urban forestry
A specialization of natural resource management, concentrated on trees, that applies nature based solutions to support community equity, sustainability, resilience, and livability goals.

Urban forest master plan/UFMP
An Urban Forest Master Plan (UFMP) is a road map, providing detailed information, recommendations, and resources needed to effectively and proactively manage and grow a city's tree canopy. The plan provides a shared vision for the future of the urban forest to inspire and engage stakeholders in the care and protection of trees.

Urban tree canopy/UTC
Urban tree canopy is a measurement that encompasses the layer of leaves, branches, and stems of trees that shelter the ground when viewed from above during the growing season.