Bristol Full Canopy Assessment

Complementary to the public tree inventory, the LANDS semester students completed an i-Tree Canopy assessment for the inventoried area in Bristol, Vermont. i-Tree Canopy is a free, easy-to-use online application that allows users to assess total tree cover over an area based on randomly- generated map points and user-defined land cover types. The tool also assigns monetary values to the benefits associated with the overall tree canopy cover. The aim of this assessment is to help citizens and decision-makers better understand the existing and potential tree canopy – encompassing public and private land – in their community.

Figure 8 compliments the i-Tree Streets analysis of the benefits provided by Bristol's public trees by estimating the air quality benefits and corresponding monetary value for the full urban forest canopy. Of note is an estimated $6,906 in annual CO_2 sequestration and $174,132 in cumulative CO_2 storage.

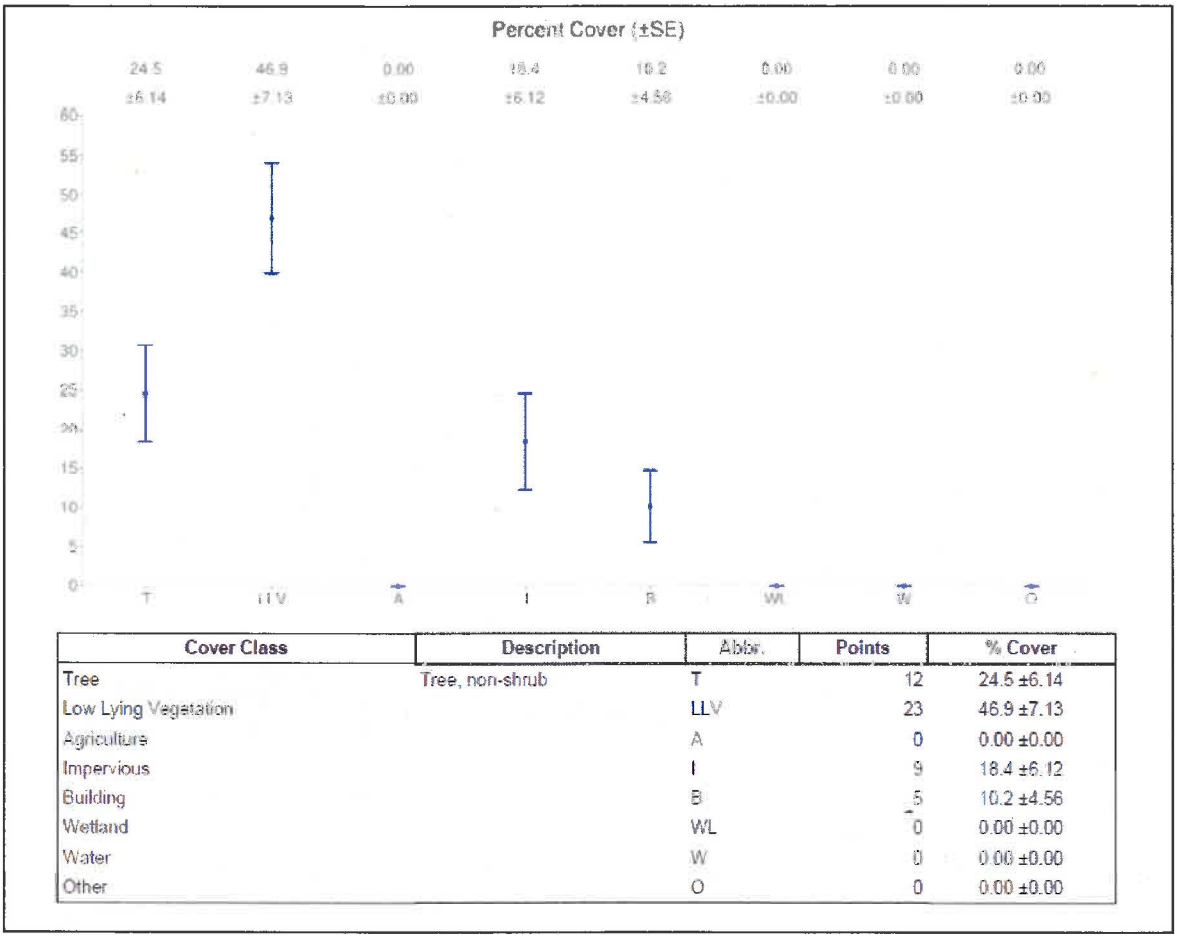
Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$2.73	±0.69	64.51 lb	±16.18
NO2	Nitrogen Dioxide removed annually	$4.71	±1.18	351.76 lb	±88.24
O3	Ozone removed annually	$245.18	±61.50	1.75 T	±0.44
PM2.5	Particulate Matter less than 2.5 microns removed annually	$506.84	±127.14	170.24 lb	±42.70
SO2	Sulfur Dioxide removed annually	$0.82	±0.21	221.67 lb	±55.61
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$178.00	±44.65	1,173.50 lb	±294.37
CO2seq	Carbon Dioxide sequestered annually in trees	$6,906.42	±1,732.47	356.69 T	±89.47
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$174,132.47	±43,680.94	8,992.90 T	±2,255.86

Figure 8: i-Tree Canopy assessment estimates for air quality benefits of Bristol's full canopy.

Based on the Bristol i-Tree Canopy assessment, approximately 24.5% of Bristol's inventoried area is currently occupied by tree canopy (Figure 9). In consideration of the other land cover types present, Bristol could potentially increase its total tree canopy cover by an additional

46.9% on agricultural and open lands of low-lying vegetation and, with strategic planning, 18.4% on impervious surfaces (parking lots, playgrounds, along the ROW) (Figure 9); In total, there is currently potential to increase overall tree canopy cover in Bristol by 65.3%. Currently 10.2% of the area is occupied by buildings, not suitable for tree planting (Figure 10).



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	12	24.5 ±6.14
Low Lying Vegetation		LLV	23	46.9 ±7.13
Agriculture		A	0	0.00 ±0.00
Impervious		I	9	18.4 ±6.12
Building		B	5	10.2 ±4.56
Wetland		WL	0	0.00 ±0.00
Water		W	0	0.00 ±0.00
Other		O	0	0.00 ±0.00

Figure 9: i-Tree Canopy assessment for the area covered in the public tree inventory for Bristol, Vermont, including both public and private land. The above image shows the ground cover composition distribution of total area inventoried.

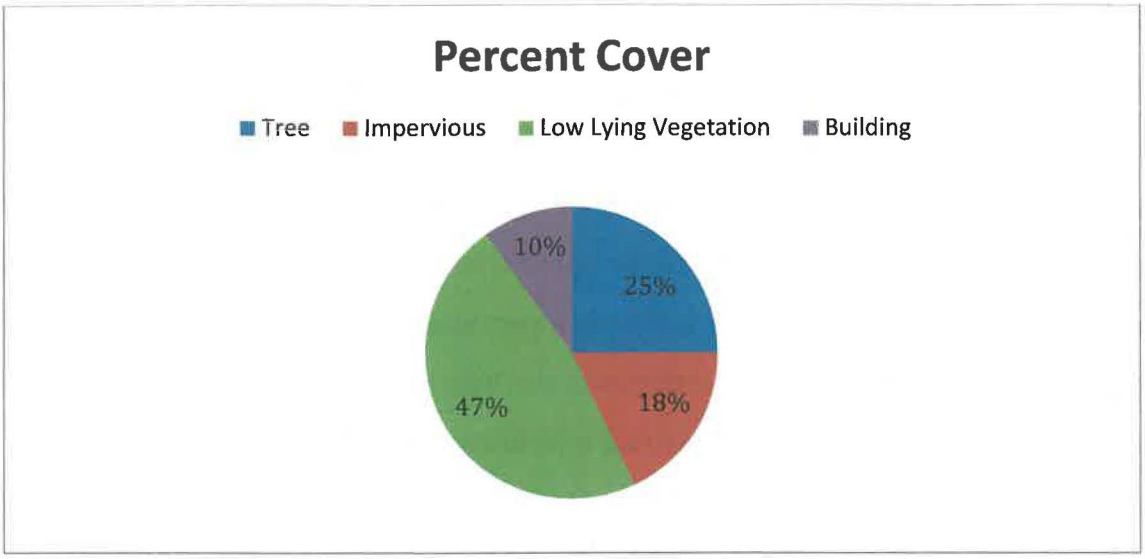


Figure 10: Downtown Bristol ground cover analysis, by percentage, using i-Tree Canopy.

Discussion and Recommendations

Urban Forest Diversity and Structure

An important best management practice in urban forestry is to maintain a diverse range of species. It is recommended that communities work towards a goal of no more than 20% representation of a single genus (for example: *Quercus*) in a tree population and no more than 10% of one species (for example: *Quercus rubra*). Resistance to disease and insect infestation is one of the many reasons why diversity within the urban forest is of paramount concern. A more diverse forest will be more resistant to environmental stressors, and is therefore more likely to remain healthy and resilient in the face of change. Furthermore, by maintaining higher genera and species diversity, a community can prevent a rapid loss of canopy (and its benefits) due to insect and disease issues.

In downtown Bristol, 48% of inventoried public trees were in the maple (*Acer*) genus, which is more than double the recommended representation within the community's urban forest. Specifically, sugar maple, Norway maple, red maple, boxelder, and silver maple – all members of the *Acer* genus – represent 21%, 10%, 6%, 4%, and 4% of the species diversity respectively. Sugar maple is the most prevalent species in Bristol. Norway maple is the second most

prevalent species and is considered to be a non-native invasive species. Although an aesthetically pleasing and hearty tree, Norway maple can spread into nearby forests and out-compete native species such as sugar maple. In fact, Vermont's Plant Quarantine Rule prohibits the movement, distribution, and sale of Norway maple, as well as other invasive plant species. Ash trees (genus *Fraxinus*) make up 6% of the public tree canopy of Bristol. Invasive tree pests currently threaten both ash and maple trees; the emerald ash borer (EAB) threatens the former and Asian longhorned beetle (ALB) is a threat to the latter. While neither of these pests have been discovered in Vermont, the largest ALB infestation in North America is a little over 50 miles to Vermont's south, in Worcester, MA and with the discovery of EAB in New Hampshire in 2013, Vermont is now surrounded on all sides by states or provinces with isolated infestations of EAB.

***Recommendation*:** Develop species, structural, and age diversity by planting new species and increasing the number of lesser represented species using best management practices in order to promote long-term health and resilience of individual trees and Bristol's urban forest.

***Recommended action practices*:**

- We advise against planting high-density stands of the same species (monocultures) whose close proximity may be conducive to the spreading of disease.
- Due to the high number of existing maple (*Acer)* trees in Bristol, we suggest selecting non-maple trees for future plantings.
- We suggest planting tree species that have grown successfully in the area that do not show any signs of diseases and deformity, and that are not non-native invasive species (specifically Norway maple). For more information on site assessment and species selection, refer to VT UCF's Tree Selection Guide at http://www.vtcommunityforestry.org/resources/tree-care/tree-selection.
- Existing ash (*Fraxinus*) trees should be consulted and regularly monitored for signs of EAB, and additional ash trees should not be planted.
- Plan for the arrival of EAB by using the Community Preparedness Toolbox, available at http://www.vtinvasives.org/tree-pests/community-preparedness.

- Encourage citizens to participate in the Vermont Forest Pest First Detector Training to expand local capacity to identify and monitor for invasive forest pests.
- In order to diversify both species composition and age structure, refer to the 106 identified vacant planting locations within the public ROW and develop a strategic planting plan.
- In planning for future tree plantings, make sure the right tree is being planting in the right place. Consider obstructions above ground (power lines) and below ground, minimize grey infrastructure conflicts (sidewalks, streets, buildings, etc.), and understand available soil volume, mature size (height and spread), branching patterns, environmental tolerances (exposure, salt, and drought), and desired function when choosing species.
- Encourage residents to plant trees on their properties that increase species diversity, age structure, and overall tree canopy benefits to the community.

Maintenance

Proper tree maintenance, especially pruning, can extend the life and health of trees, as well as reduce public safety issues. There are four main pruning practices of note:

- Crown cleaning: removes dead, diseased, and damaged limbs
- Crown thinning: selective removal of stems and branches to increase light penetration and air movement throughout the crown of a tree
- Crown raising: the removal of lower branches over 2 inches in diameter to provide clearance for pedestrians and vehicles
- Crown reduction: removing individual limbs from structures or utility wires

In addition to pruning, proper mulching for soil health, moisture retention, and protection from mechanical damage is encouraged. Finally, for newly planted trees, an irrigation regime should be in place to ensure proper establishment and tree root regeneration.

***Recommendation*:** Establish a routine maintenance cycle, implemented by trained professionals and overseen by the Bristol Conservation Commission for all public trees to promote tree health and reduce any threat to public safety.

***Recommended action practices*:**

- Complete a full inventory of all public trees in Bristol in order to lay the foundation for establishing a routine maintenance regime for all town-managed trees.
- Work with VT UCF to ensure municipal tree maintenance staff is trained in best management practices.
- Establish a systematic pruning cycle to reduce branch and tree failures due to poor structure, minimize conflicts with people and infrastructure, improve line of sight, and reduce storm damage. When trees are located near electrical utility lines, it is important to work directly with the local utility company.
- Encourage Bristol citizens to participate in VT UCF's Stewardship of the Urban Landscape (SOUL) training course to continue to build local capacity to care for and promote Bristol's canopy.

Urban Forest Health

Overall, Bristol's downtown public trees are in good health. Only 2% (12) of the inventoried trees were considered to in "Poor" condition, and 1% (6) was found to be "Dead". The eastern section of Garfield Street had a particularly large number of trees in relatively poor condition. There were 44 trees flagged to be revisited by a professional arborist or a member of the BCC. Many of these trees overlap those designated to be in "Poor" condition or "Dead", but others were likely noted because of conflict with utility wires or other infrastructure. See Appendix D for a map detailing the locations of the "Fair", "Poor", and "Dead" trees in Bristol and a map indicating the location of the trees requiring a consult.

Low soil volume and fertility, exposure to salt spray, root damage, mechanical damage to the stem, poor pruning, and improper planting are some of the contributing factors that may lead to decreased tree health in an urban setting.

Recommendation: Continue to monitor trees in "Good" and "Fair" condition, plan to lose trees in "Poor" condition, remove "Dead" trees to increase overall urban forest health, and involve the community, especially youth, in tree plantings, stewardship, and maintenance.

Recommended action practices:

- Visit and assess the 44 trees flagged for consultation in a systematic and timely fashion.
- Remove the 6 dead public trees identified.
- Continue to monitor the health of the trees in "Good" and "Fair" condition and record any changes in tree health.
- Focus efforts on the east section of Garfield Street, an area of high use and high value to the public that contains a large number of trees in poor condition.

Assessment Tools

i-Tree software developed by the USDA Forest Service, assesses the value and potential expansion of Bristol's urban tree canopy. i-Tree Streets determined the economic value of the ecosystem services provided by the 562 inventoried public trees in Bristol. Bristol's urban forest generates about $62,613 annually through the benefits of air quality improvement, CO_2 sequestration, electricity and natural gas, aesthetics, and stormwater control. On average, each tree offers $111.61 in service or savings every year. The trees of Bristol provide services to the town in the following ways:

- **Aesthetics**: Urban trees can make an urban or suburban environment a more pleasant and satisfying place to live, work, and spend leisure time (Dwyer et al. 1991). In monetary terms, presence of shade trees can significantly increase property value. Trees also provide numerous health benefits. For example, hospital patients with window

views of trees have been shown to recover faster than patients without such views (Ulrich 1984).

- **Air quality**: Trees improve air quality by removing air pollutants through their leaves, altering emissions from building energy use, and by lowering air temperature.
- **Energy use**: Trees influence thermal comfort and energy use by providing shade, transpiring moisture, and reducing wind speeds. Over 100 million trees have been established around residences in the U.S., saving $2 billion annually in reduced energy costs (Akbari et al. 1988).
- **Stored Carbon Dioxide**: Urban trees can affect climate change by storing carbon in their tissues and reducing emissions through lowered building energy use. Urban trees in the contiguous United States store 770 million tons of carbon, which is valued at $14.4 billion (Nowak and Crane 2002).
- **Storm water run-off**: Trees and soil improve water quality and reduce costs associated with storm water treatment by retaining or slowing precipitation flow.

Using a random sample method and based on assessing land cover types, i-Tree Canopy measured the overall tree canopy cover within the boundaries of Bristol's inventoried area, capturing both private and public tree canopy.

Recommendation: Use the information generated through the i-Tree Streets and i-Tree Canopy programs to promote local stewardship and investment in urban forest management. Explore the other free assessment tools in the i-Tree tools suite (www.itreetools.org).

Conclusion

Trees in our urban landscapes contribute to environmental integrity, social cohesiveness, economic activity, cultural heritage, and overall well-being. This report is one component of a long-term effort by the Town of Bristol to understand, manage, and steward its urban forest. The recommendations outlined in this report are based on the LANDS students' observations and data analysis combined with the experience and evaluation of VT UCF staff. The Bristol

Conservation Commission should consider these provided recommendations based on their long-term vision and current capacity.

Literature Cited

Akbari, H.; Davis, S.; Dorsano, S.; Huang, J.; Winnett, S. 1992. *Cooling our communities: a guidebook on tree planting and light-colored surfacing*. Washington, DC: U.S. Environmental Protection Agency. 217 p.

Bristol Downtown Community Partnership. 2014. "About Bristol." *Discover Bristol Vermont*. Retrieved September 23, 2014 from http://discoverbristolvt.com/bristol/about/

Dwyer, J.F., H. W. Schroeder, and P. H. Gobster. 1991. *The significance of urban trees and forests: toward a deeper understanding of values*. Journal of Arboriculture 17: 276-284.

Morales, D., B. N. Boyce, et al. (1976). *The contribution of trees to residential property value. ASA Valuation* (23): 26-43.

Morales, D.J., F.R. Micha, et al. (1983). *Two methods of valuating trees on residential sites.* Journal of Arboriculture 9(1): 21-24.

Nowak, D.J.; D. E. Crane. 2002. *Carbon storage and sequestration by urban trees in the USA.* Environmental Pollution 116(3): 381-389.

Ulrich, R.S. 1984. *View through a window may influence recovery from surgery*. Science 224: 420-421