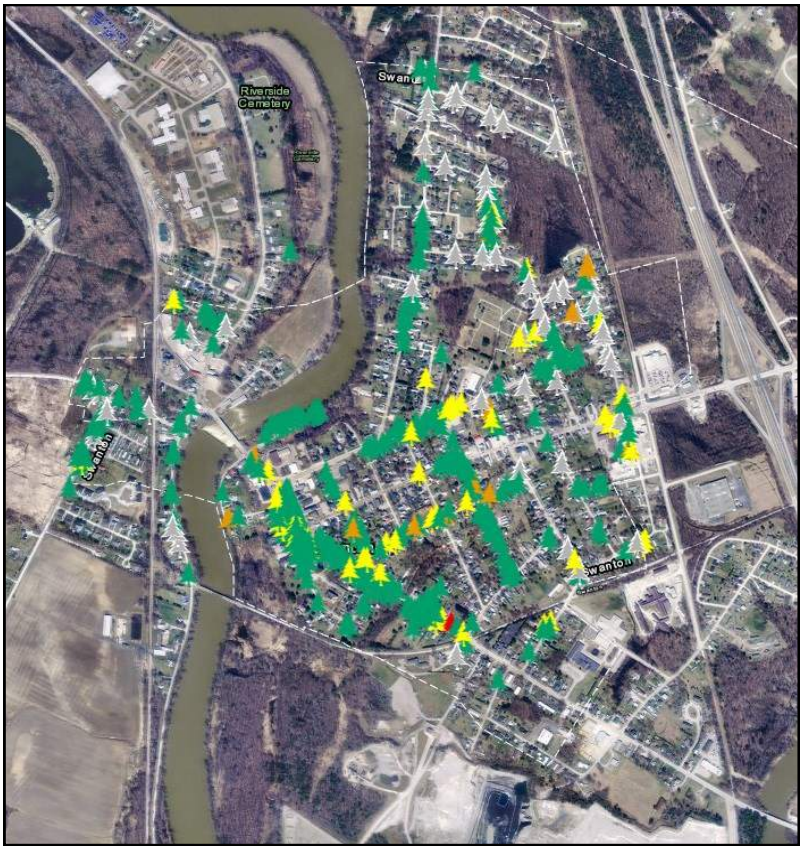
Swanton Public Tree Inventory Report



Prepared for the Village of Swanton by the Land Stewardship Program and the Vermont Urban & Community Forestry Program
October 2014

VERMONT
AGENCY OF NATURAL RESOURCES

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

PLANT LIVE GROW
VERMONT URBAN & COMMUNITY FORESTRY PROGRAM

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Acknowledgements

This report was created by the Land Stewardship (LANDS) intern team and the Vermont Urban & Community Forestry Program based on work done for the Village of Swanton, Vermont during the summer of 2014. We would also like to thank Reg Beliveau Jr., Swanton Village Manager and Mike Menard, Public Works Foreman, for their help in planning and designing the public tree inventory project.

LANDS is grateful to the Rubenstein School of Environment and Natural Resources (RSENR) at UVM and the Student Conservation Association (SCA) for facilitating this internship program. We also greatly appreciate the Aiken Center at UVM for providing resources and housing during our office work days.

About the Vermont Urban & Community Forestry Program

The field of forestry management is not confined to the natural areas and forests of Vermont, but extends to the urban and rural spaces where trees play important roles. The trees in public parks, along roadsides, town greens, and municipal forests compose our urban and community forests and merit careful stewardship. The Vermont Urban & Community Forestry (VT UCF) program is a collaborative effort between the Department of Forests, Parks, & Recreation, University of Vermont Extension, and the USDA Forest Service. VT UCF provides technical and financial assistance as well as educational programs and resources for the management of trees and forests in and around Vermont communities. The mission of VT UCF is ***to lead citizens, businesses, and governments in understanding the value of urban and community forests and promote civic responsibility for and participation in the stewardship of these resources for this and future generations***. Since 1991, the program has been guided by a small staff and a twenty-member advisory council. The council meets quarterly to share information and advise the program; its members come from various professional associations, non-profits, educational institutions, tree boards, regional officials, and state agencies.

The trees in our communities offer a wide variety of environmental, social, and economic benefits to the surrounding community, including stormwater control, CO_2 sequestration, and aesthetic value. VT UCF seeks to maximize these benefits by working with state and municipal officials and dedicated volunteers to steward the urban forest's ecological integrity and diversity. VT UCF's programming and support reaches 100 Vermont communities annually. More information about VT UCF and its programming can be found at www.vtcommunityforestry.org.

About LANDS

The field of conservation is rapidly evolving to meet the growing demands of society. New ideas and strategies are changing how we conserve and steward the land; The Land Stewardship Program (LANDS) is one of these new ideas. During the Great Depression, the Civilian Conservation Corps model was pioneered as a means to promote stewardship in the nation and provide jobs for the unemployed. The idea has since been reinvented many times by local and state corps across the United States. However, the theme is the same: young people learning and growing through service. LANDS is an innovative *College Conservation Corps* designed to train tomorrow's conservationist practitioners and leaders, and is a pilot partnership between the University of Vermont and the Student Conservation Association in its eighth year of successful programming.

Thanks to college-level education and prior experience in environmental science fields, LANDS interns are able to take on projects that are more technical than the work traditionally done by conservation crews. LANDS interns draft management plans, map areas of interest using GPS and GIS, inventory resources, survey for non-native species, survey soils, and evaluate river geomorphology. Municipalities, land trusts, state agencies, university researchers, national forests and parks, and volunteer-managed conservation organizations all benefit from LANDS's high quality, affordable services. LANDS interns are advanced undergraduates and recent graduates with natural resource experience from all over the world, and they bring a wide range of skills and interests to the program. LANDS is a unique service-learning model that

addresses an ever-expanding list of conservation needs, while training students as future environmental leaders.

The Summer 2014 LANDS Crew

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Executive Summary

The goal of the public tree inventory was to document the location, size, species, and condition of trees planted within the public right-of-way (ROW) and on village-owned land within the Village of Swanton. This information will provide local decisions-makers with a better understanding of the health and benefits of Swanton's urban forest and can facilitate planning for future tree planting and maintenance using a map-based tree inventory system.

The inventory was commissioned by the Swanton Village Manager and planning for the inventory began in the spring of 2014. LANDS interns completed an inventory of **449 trees** located within the ROW of 49 streets and village-owned properties and identified 59 specific locations or strips of public land appropriate for future tree plantings. Staff from VT UCF provided tree identification training, and technical assistance in data collection and analysis. This report was drafted in the summer of 2014 by the LANDS interns and subsequently edited and supplemented by VT UCF program staff. It presents the results of the inventory and basic assessment of the trees and canopy cover in Swanton Village.

Local government, conservation agencies, and private landowners all play an important role in monitoring and maintaining urban forests. Urban trees provide a number of benefits to a community, including reducing stormwater runoff, reducing air pollution, providing shade, sequestering carbon dioxide, enhancing property values, and improving the aesthetics of the community. The 449 public trees that were inventoried provide an estimated **$61,214 in benefits annually** to the residents of Swanton. In addition to the public trees inventoried, an urban tree canopy (UTC) assessment was completed for the full inventory (public and private) area, which indicated **existing canopy cover of 26%** and a stored value carbon dioxide of over $330,125.

Summary of findings

Forest Diversity

- Of the 449 public trees, there are 27 different species in 21 different genera.

- The top five most common tree genera: *Acer* (maple), *Picea* (spruce), *Malus* (apple), Populus (polar), and *Quercus* (oak), make up 87% of the public tree population.
- 62.5% percent of the public trees are either ash or maple; both of these genera are currently threatened by invasive tree pests; ash species by the emerald ash borer (EAB) and maple species by the Asian longhorned beetle (ALB).
- The top five most common species: Norway maple (14.9%), red maple (14.5%), sugar maple (13.8%), crabapple (6.0%), and blue spruce (5.8%) comprise 55% of the stocking.

Forest structure

- The diameter distribution – indicative of age structure – of Swanton Village trees is generally well-distributed, with the majority (271 or 60%) of trees falling within the 6-24" size category.
- 66 (15%) trees fall within the 0-6" size category.
- The remaining 112 (25%) are greater than 24" in diameter.

Forest Cover

- Canopy cover (public and private property) in Swanton Village was assessed to be at approximately 26%.
- Trees could potentially cover an additional 54% of the Village's land surface; these "possible UTC" areas include grass and impervious surfaces (e.g. parking lots, paved playgrounds, and along the ROW).
- The remaining 20% of the Village's area is buildings, streets, water, and other permanent features and is generally unsuited to UTC improvement.

Forest health

- An overwhelming majority (83.1%) of the trees inventoried was assessed as being in "Good" condition; of the remaining trees 76 were considered to be in "Fair" or "Poor" condition and only 1 public tree was found that was dead.
- There were 75 (16.7%) trees flagged as in need of a future consultation.

Benefit output

- The total annual energy (electricity and natural gas) benefits of all inventoried trees in Swanton Village are valued at $26,008.
- Swanton Village public trees intercept 971,660 gallons of rainfall each year, yielding an annual storm water cost benefit of $7,773.
- Swanton Village public trees currently store 2,916,827 lbs. of carbon.
- The annual aesthetic benefit of Swanton Village's public trees is valued at $21,358.
- When considering all the benefits trees have on a community (energy, carbon, air quality, storm water and aesthetic), Swanton Village public trees have a total average annual benefit value of $136 per tree and cumulative annual benefit of $61,214.

Summary of recommendations

We recommend that the Village of Swanton work on continuing to ***increase the diversity*** of tree species to ensure the long-term health and resilience of Swanton's urban forest. Plant a mix of species versus high-density stands of the same species whose close proximity may be conducive to the spreading of disease and pests.

Monitor tree health, specifically for signs and symptoms of EAB, ALB, and other forest pests and diseases.

Maintain tree health by ensuring that those who are caring for Swanton's public trees are trained in best tree care practices; prune all public trees to promote long-term structural integrity, irrigate newly-planted trees, and prevent mechanical damage to trees.

Plan for the arrival of EAB by developing a community preparedness and response plan.

Inventory the remaining public trees within the Village that were not covered in this inventory project (see Appendix A) to have a complete foundational inventory; develop a long-term plan for updating the inventory on a regular cycle.

Establish a routine systematic trimming cycle for all public trees to reduce future tree failures due to poor structure, minimize conflicts with people and infrastructure, improve lines of sight, reduce storm damage, and protect public safety.

Develop a comprehensive management and urban forest master plan based on this inventory report.

Communicate about the benefits of Swanton Village's public trees at local events, work towards increasing local stewardship and awareness of urban forest benefits and health, and encourage participation in VT UCF educational programming such as the *Stewardship of the Urban Landscape* course and the *Forest Pest First Detectors* trainings.

Initiate the process of establishing a Swanton Village Tree Advisory Board or Tree Committee to give citizens an opportunity to be engaged in decisions regarding public trees and tree stewardship.

Collaborate with town planners and decision-makers to strategically plant trees in high-use areas such as Swanton Beach and along the major Village roads with wide grassy planting strips.

The LANDS crew collected data on Swanton Village's public trees for two rainy field days in July.

Introduction

Project Description

VT UCF is currently working on a project funded by the USDA Forest Service to assist twenty priority communities in Vermont in moving their forestry programs forward. The project, *Care of the Urban Forest*, is a multi-year effort that aims to support these communities in three specific ways: (1) conducting a public tree inventory to assess urban forest structure, diversity, and health; (2) helping the community in the development of an urban forest management plan (or master plan) using information from the inventory; and (3) providing technical training for volunteers and town employees to promote the proper care and management of public trees.

The Village Manager in Swanton, Reg Beliveau Jr., has been increasingly interested in green infrastructure enhancements (rain gardens, tree plantings) as a measure to mitigate stormwater issues, to calm traffic, and to aesthetically improve the major roadways leading to downtown Swanton Village. While there are not currently many trees planted within the ROW along the Village streets, Swanton does take pride in its large Village Green, upon which the Village has funded the planting of a number of trees in recent years. There is currently no formal committee or board within the Village to take the lead on urban forestry enhancement projects; interest in a public tree inventory was expressed by the Village Manager and planning occurred over the spring, including a number of site visits with the Village Manager and the Public Works Foreman.

The goal of the public tree inventory was to document the location, size, species composition, and condition of trees planted within the public right-of-way (ROW) and on Village-owned land in Swanton Village. Summer interns from the LANDS program conducted a comprehensive public tree inventory over the course of two days. This inventory establishes a baseline for future inventories, management decisions, and improvements to Swanton's urban forest.

Swanton Community Profile

The Village of Swanton, incorporated in 1888, is located in the northwestern corner of Franklin County, Vermont, with Lake Champlain at its west border and Quebec Province (Canada) to its north. The Village – population of approximately 2,500 – is the economic center of the Town of Swanton and home to shops, the library, municipal buildings, schools, and a large town green. In 1961 the Queen of England bestowed a gift of two swans to Swanton, a tradition that persists today; a pair of swans live in the center of the green during the summer, and while they aren't the originals (or even descended from them); Swanton still calls them the "Royal Swans". There are major transportation routes that run through or directly adjacent to Swanton (Rt. 78, Rt. 7, and Interstate 89) and it has a rich history of freight transportation along a railroad and the Missisquoi River, which runs through the downtown. The 6,600-acre Missisquoi National Wildlife Refuge and Maquam Waterfowl Area are not far from the Village (Village of Swanton, 2014).

Methodology

Prior to the public tree inventory, VT UCF staff met numerous times with the Swanton Village Manager to plan for the inventory. Fifty-nine streets and village-owned properties in Swanton were selected to be included in the inventory. In total, the land area of

Importance of Inventory and Urban Forestry in Vermont

An inventory of urban trees provides a record of the trees present in a community. An inventory can provide information about the species, size, health, and location of each tree and future management needs. This detailed information allows town planners to estimate the monetary contributions of their community's green infrastructure. In the event of a disease outbreak or insect infestation, data from an inventory may assist in monitoring and preventing the spread of a forest health epidemic. An inventory can also help build public support for expanding community forests and to guide future urban planning.

Urban trees improve the quality of life for Vermont communities in a variety of ways. The most readily apparent benefit is the aesthetic value that trees provide a street, home, or public space. Along with this beauty is the functional benefit of providing shade along the streets in the summertime and blocking wind to reduce heating costs in the wintertime. The presence of trees has been shown to positively affect property values (Morales 1973; 1983) and boosts foot traffic in commercial areas. Parks and tree-lined sidewalks promote physical activity by creating shaded, comfortable outdoor spaces. Many types of urban wildlife depend on trees as sources of food and shelter. Unseen environmental benefits of urban trees include improvements in air quality and temperature regulation through reduction of the heat island effect. Trees can mitigate noise pollution common in an urban environment and can clean and conserve water by controlling run-off. Additionally, urban forests create opportunities for environmental education, community engagement and in some instances can be related to crime reduction. Trees are an integral part of the green infrastructure of a community and contribute to keeping our families healthier and our everyday lives more fulfilling.

the inventory was about .8 of a square mile, representing less than 2% of the total land area of the Town of Swanton, but including the most densely populated sections. The ROW boundaries for all streets were provided by the Swanton Village Manager. The list of streets and sites with associated ROW boundaries is found in Appendix A and maps of the inventory area are found in Appendix C.

VT UCF has developed an inventory system in collaboration with the VT Agency of Natural Resources' (ANR) GIS team. The map-based inventory system uses the application "Collector" by ArcGIS for data collection and is linked to the ANR Atlas online mapping tool.

On July 14th and 15th, 2014, four teams of LANDS interns walked along pre-designated streets and sites of Swanton, inventorying the public trees and identifying appropriate potential planting locations or green strips (recorded as "Vacant"). To ensure that only public trees were inventoried (opposed to trees on private property), each team had a list of the ROW boundaries for each street. Their first step upon reaching a new street was to determine the extent of the ROW from the curb (or edge of the road); the team measured the road width, subtracted that number from the full ROW boundary, and then divided the number in half to determine the ROW extent back the curb on each side of the street. The following equation expresses this process:

ROW distance from curb (or edge of road) = (ROW width - road width)/2

Each public tree identified was recorded into the "Collector" application using an iPad, provided by VT UCF. "Collector" is map-based and uses GPS and a base layer map to allow the user to input information about a tree, linking it to a particular geographic location. Data recorded for each tree included condition, tree number, street name, species, diameter class (using a diameter at breast height, or DBH, measurement), explicit maintenance practice recommendations, a consultation recommendation, comments, and nearest house or building number. In most cases, a picture was also taken of each tree or vacant (potential) tree location. A full list and description of the parameters used in data collection can be found in Table 1.

Table 1: Parameters for Inventory Data Collection

Data Parameters	Description
Site ID	Street name or property name.
Tree Number	Count starts at 1 for each street/site. Unique to tree.
Species	Common name. Include in comments box if not listed.
Tree Condition	• *Good:* full canopy (75-100%), no dieback of branches over 2" in diameter, no significant defects, minimal mechanical damage • *Fair:* thinning canopy (50-75%), medium to low new growth, significant mechanical damage, obvious defects/insects/disease, foliage off-color and/or sparse • *Poor:* declining (25-50%), visible dead branches over 2" in diameter, significant dieback, severe mechanical damage or decay (over 40% of stem affected) • *Dead:* no signs of life, bark peeling; scratch test on twigs for signs of life (green) • *Vacant:* potential spot for a tree within the public ROW. Add "small", "medium", or "large" in the comments box - Small= max 30' at maturity, presence of overhead wires, minimum planting space 4' x 4' - Medium= 30-50' at maturity, green belts over 6' wide, no overhead wires - Large= 50'+ at maturity, parks and open space
Diameter (DBH)	Diameter taken at 4.5' above ground in classes of 0-3", 3-6", 6-12", 12-18", 18-24", 24-36", 36-42", 42"+. If on slope, uphill side measured. If abnormal growth, measured above or below growth. If multi-stemmed, each stem's DBH is squared, all squares summed, and the square root taken; indicate "multi-stemmed" in comments box.
Consult	• *Yes:* any one defect is affecting >40% of the tree, posing a hazard to people/infrastructure/cars, growing into utility wires, dead or poor condition, ash tree showing evidence of woodpecker flecking, blonding, epicormic branching/water sprouts, and/or suspicious exit holes • *No:* no major defects, tree in good or fair condition
Decay	Is there decay present? Must select Yes or No.
Prune	• Yes: any of the following conditions exists: There are broken branches o There are branches that are overlapping/touching/growing into each other o The crown of the tree is over-crowded o There are branches that are interfering with utility lines or other built infrastructure o There are low branches that could interfere with pedestrians/vehicles/bikes, etc. • No: none of the above conditions exist and the tree does not need to be pruned at this point.
Stem-girdling Roots	Are there stem-girdling roots present? Must select Yes or No.
Stake	Is the tree young, newly-planted, and leaning? Must select Yes or No.
Remove Stake	Is the tree currently staked (should be removed)? Must select Yes or No.
Comments	Notes, elaborate on any existing conditions; max 255 characters.
House Number	Corresponding house address, numerical field. If a corner lot house is on a different street, enter house number and write "House located on X Street;

	corner tree" in comments box.
Collection Date/Time	Date and time.
Photo	Photo of full tree. Additional photos of any significant defects.

Left: each morning and afternoon the LANDS interns met to discuss and plan the most effective routes for data collection using a large parcel map.

Right: An example of a photograph of an individual tree that is attached to the record in the "Collector" application.

The data were compiled and subsequently analyzed and summarized using Microsoft Excel and ArcGIS. Data were also uploaded to i-Tree Streets in order to determine the monetary and ecosystem services benefits of Swanton's public trees inventoried and a VT UCF intern separately did a baseline assessment of Swanton Village's full tree canopy coverage, encompassing both private and public property, using i-Tree Canopy. i-Tree is a free software suite developed by the USDA Forest Service and available at www.itreetools.org.

Inventory Results

Urban Forest Diversity

Of the 449 trees inventoried within the public ROW or on Village-owned land, there were a total of 27 different species in 21 different genera. The common tree genera: maple (*Acer*), spruce (*Picea*), apple (*Malus*), poplar (*Populus*), and oak (*Quercus*) comprise 87% of the urban forest (Figure 1). Norway maple (*Acer platanoides)* (14.9%) was the most common species, followed by red maple (*Acer rubrum*) (14.5%), sugar maple (*Acer saccharum*) (13.8%), crabapple (*Malus sp.*) (6%), and blue spruce (*Picea pungens*) (5.8%) (Figure 2). Complete species and genera lists can be found in Appendix B.

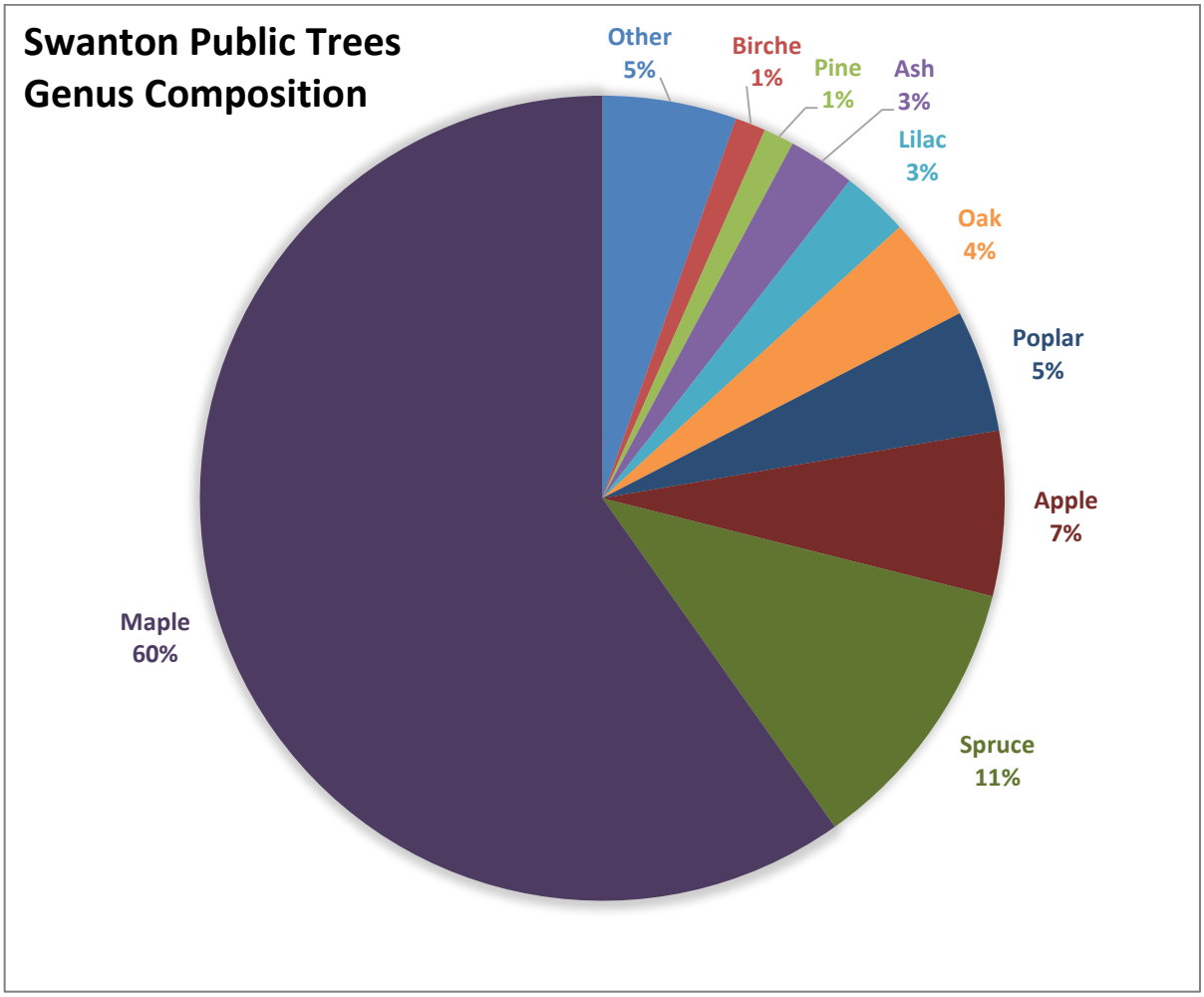


Figure 1: Chart showing tree genus by percent composition of all public trees inventoried in Swanton Village. "Other" indicates all genera that were represented by less than 1% of the total population.

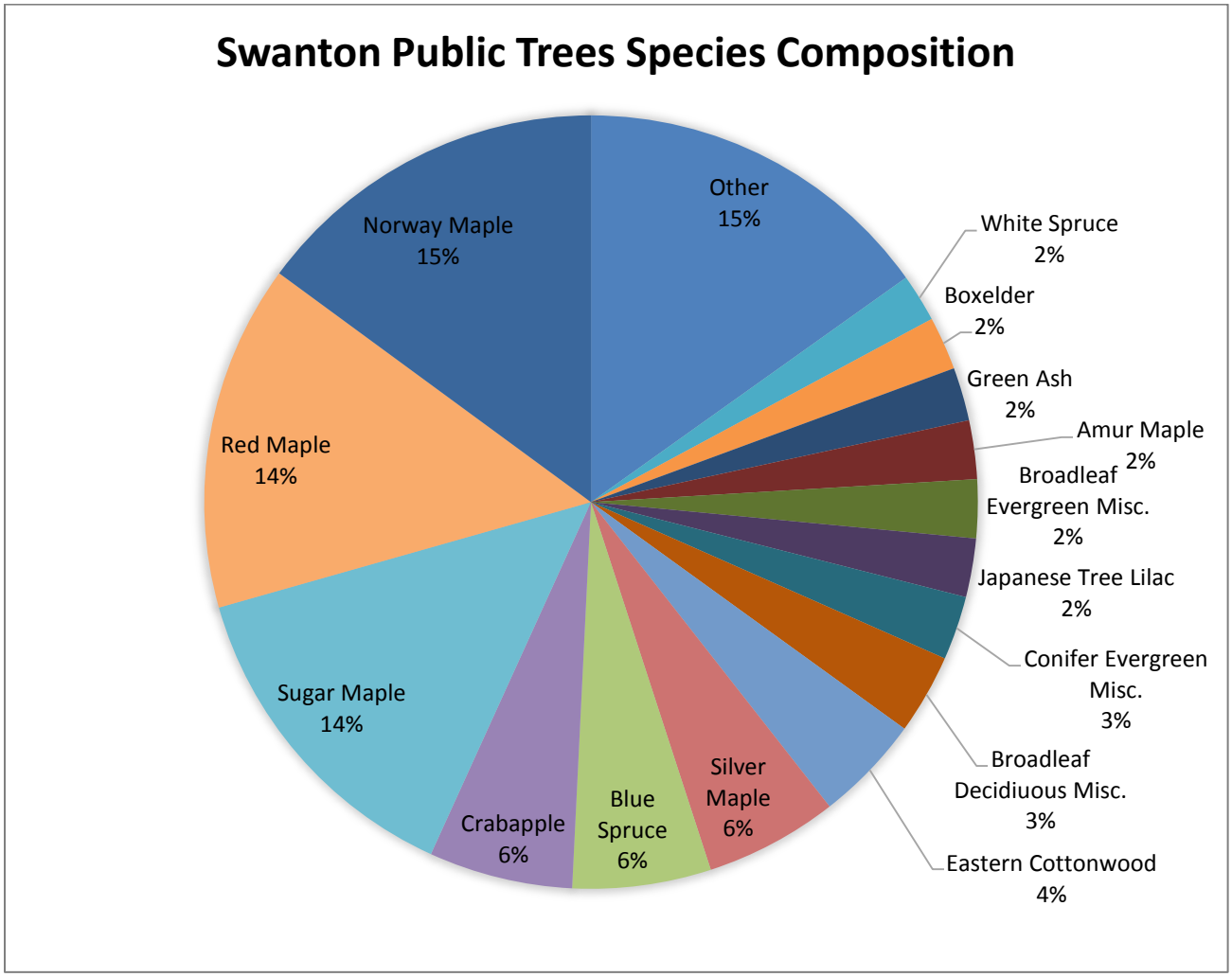


Figure 2: Chart showing tree species by percent composition of all public trees that were inventoried in Swanton Village. "Other" indicates all species that were represented by less than 2% of the total population.

Urban Forest Structure

Of the 449 public trees inventoried, 271 (60%) had a DBH of 6 – 24". There were 66 (15%) trees that measured less than 6" in diameter and the remaining 112 (25%) had a DBH greater than 24" (Figures 3 and 4). Figures 5 and 6 show the diameter distribution the three most common genera (maple, apple, and spruce; 78% of total trees) and the three most common species (Norway maple, red maple, and sugar maple; 43% of total trees). The low number of small-diameter public trees (66 under 6") indicates that there are not many new trees currently being planted. The three largest size classes represented, 30-36", 36-42", and >42" contain a total of

58 trees. These trees are growing within the public ROW or on Village-owned land and were probably not planted as street trees but left as remnants as the Village grew. The largest public tree inventoried was a 58" red oak on Church Street across from the Village Green. While not included in the inventory because it is located on private property, there was also a 50"+ eastern cottonwood observed by the inventory team.

There were 59 "Vacant" potential tree planting sites or strips identified within the public ROW It is important to note that a site, such as Swanton Beach, could be logged as having just one "Vacant" sites, but that site could house many trees. Streets such as Brown Avenue, Taylor Drive, Jones Court, and Linda Avenue are examples of sites where a number of trees could be planted. Prior to the inventory the Swanton Village Manager requested that we not place "Vacant" potential tree sites underneath any utility lines, so while small trees are often suitable under utility wires, the LANDS interns omitted these sites altogether from their assessment. The Swanton Village Office building and Swanton Beach were two other sites where a significant number of trees could be planted; there were no vacant sites identified on the Swanton Village Green. Of the 59 identified locations, 11 were explicitly indicated to be appropriate for large-growing trees, 20 would be appropriate for medium-growing trees, and the remaining 20 would be most suitable for small-growing trees.

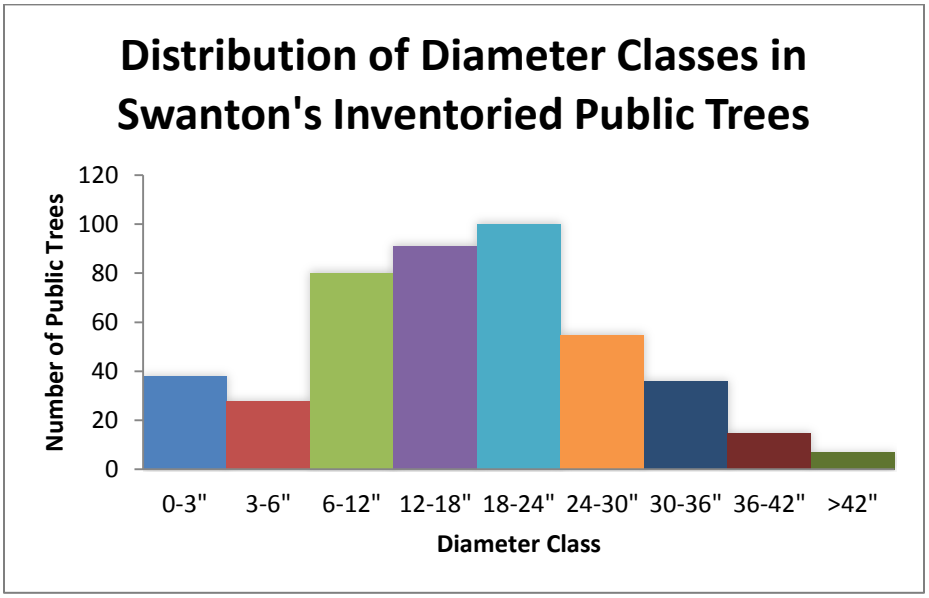


Figure 3: Graph showing number of trees in each diameter class (inches).

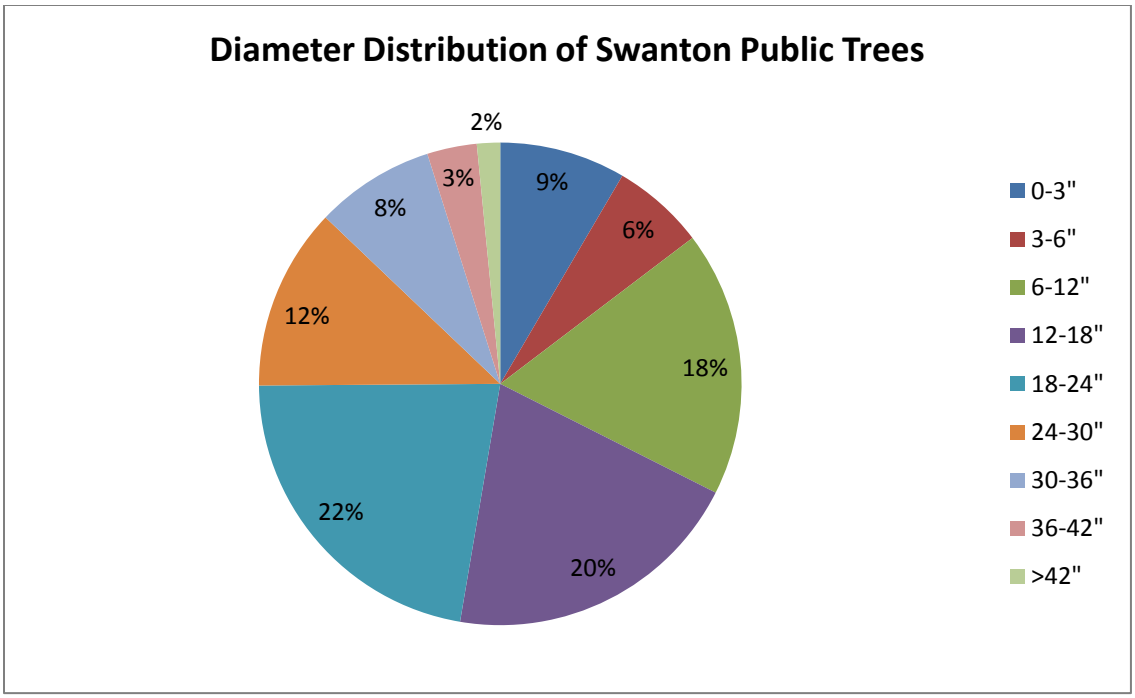
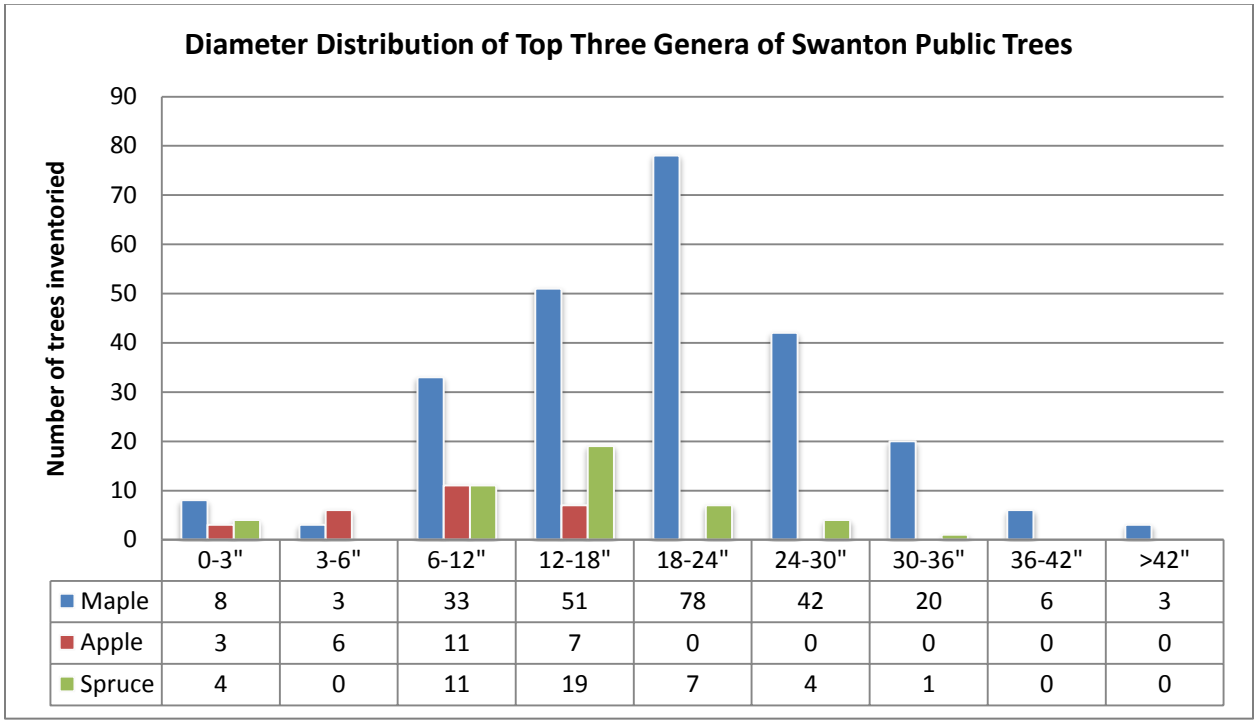
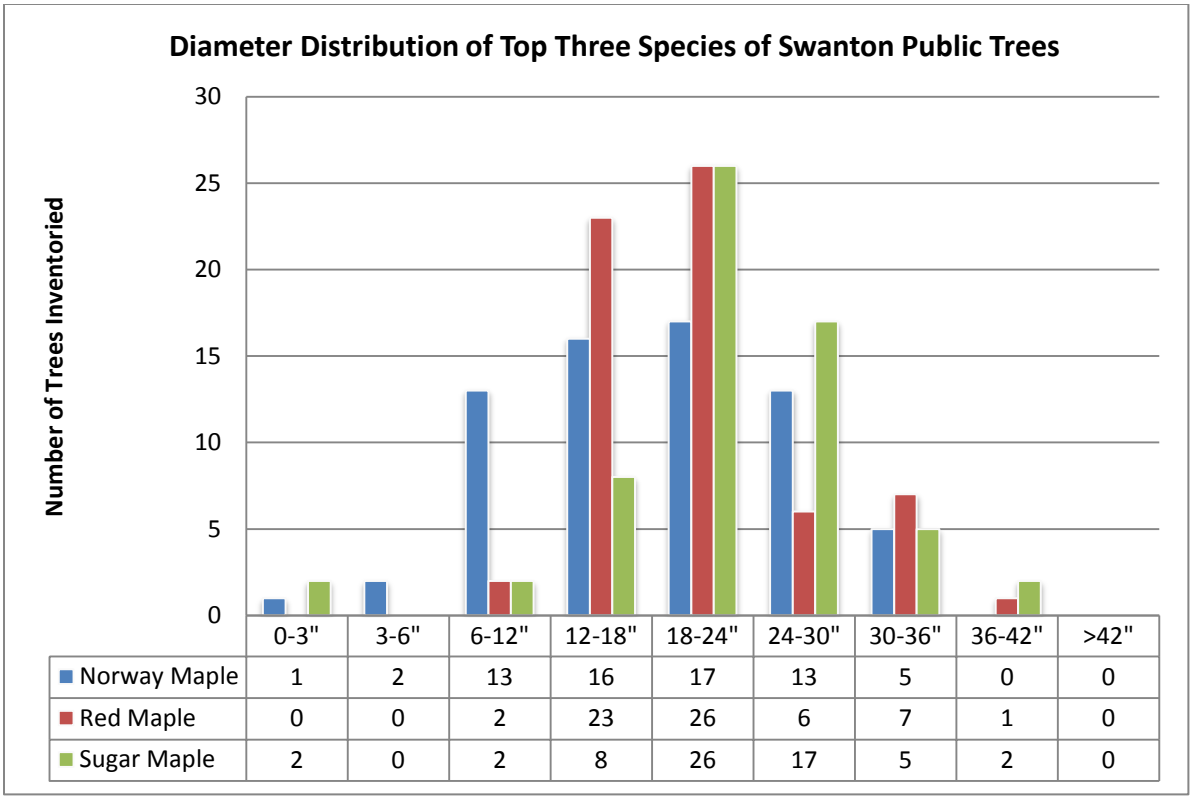


Figure 4: Diameter (inches) distribution of Swanton public trees by percentage.



	0-3"	3-6"	6-12"	12-18"	18-24"	24-30"	30-36"	36-42"	>42"
Maple	8	3	33	51	78	42	20	6	3
Apple	3	6	11	7	0	0	0	0	0
Spruce	4	0	11	19	7	4	1	0	0

Figure 5: Graph showing diameter distribution for the three most common tree genera.



	0-3"	3-6"	6-12"	12-18"	18-24"	24-30"	30-36"	36-42"	>42"
Norway Maple	1	2	13	16	17	13	5	0	0
Red Maple	0	0	2	23	26	6	7	1	0
Sugar Maple	2	0	2	8	26	17	5	2	0

Figure 6: Graph showing diameter distribution for the three most common tree species.

Urban Forest Health

An overwhelming majority (83%) of Swanton Village's inventoried public trees were assessed as being in "Good" condition; of the remaining trees, 61 (14%) were considered in "Fair" condition, 15 were in "Poor" condition, and just one was assessed to be "Dead" (Figure 7). The trees in the genera *Acer* (maple) had the most trees in fair or poor condition; however, this genera also comprised the highest percentage of overall trees inventoried. The species of the one dead tree was unidentifiable.

There were 75 trees (16.7%) that were flagged for a consult during the inventory and should be reassessed by an International Society of Arboriculture Certified Arborist in a timely matter. Trees that were flagged for a consult expressed one or more of the following conditions:

- The tree had a defect affecting >40% of the tree,
- The tree posed a hazard to people/infrastructure/cars,
- The tree was growing into utility wires,

- The tree was dead or in poor condition, or
- The tree was an ash (*Fraxinus*) and was showing evidence of a sign or symptom of infestation by the emerald ash borer (extensive woodpecker flecking, bark blonding, epicormic branching/water sprouts, and/or suspicious exit holes).

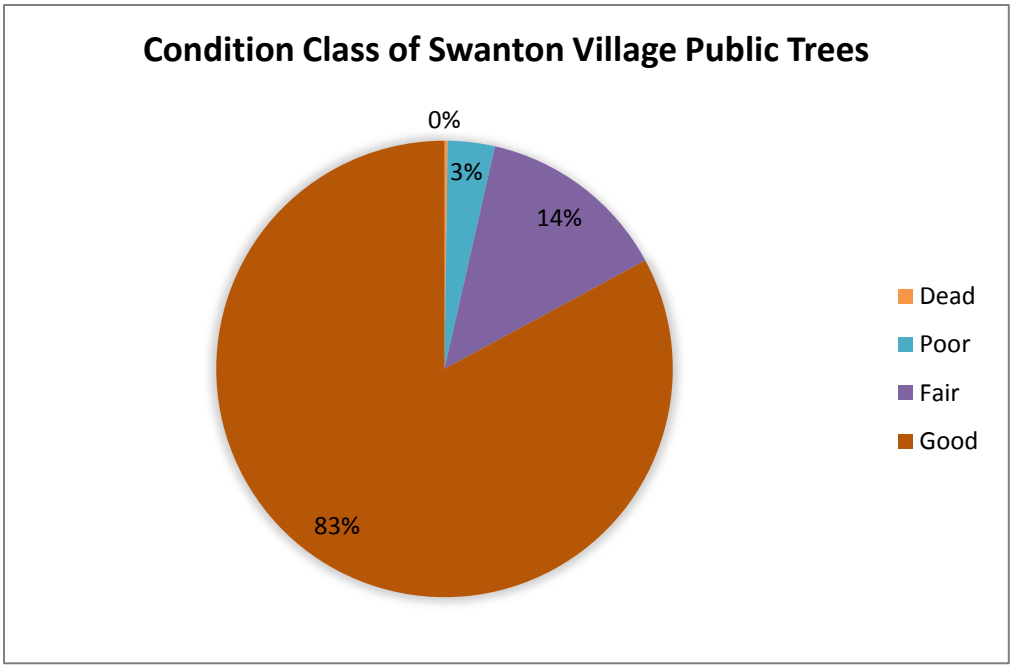


Figure 7: Chart showing condition class distribution of all public trees inventoried in Swanton Village.

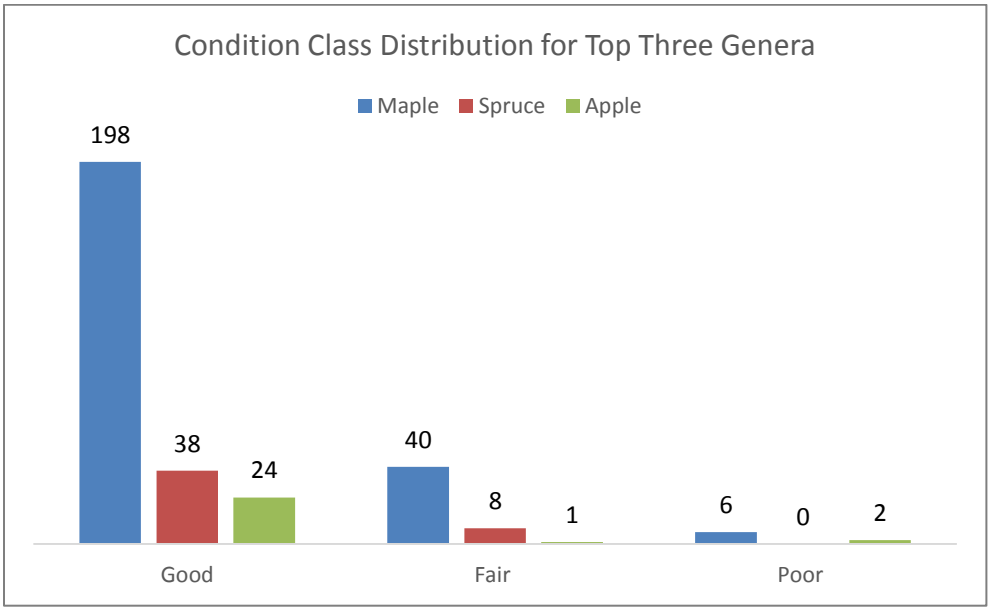


Figure 8: Graph showing the number of trees within the three most common genera displayed according to condition.

Maintenance Needs

Data was collected on presence of significant decay and a number of maintenance needs for for the public trees in Swanton Village. These attributes were selected by the Swanton Village Manager during the inventory planning process. Based on the assessment of the LANDS interns, there were 45 trees (10%) that were assessed as having decay present on the trunk or a major stem (branch). Of those 45, 22 were considered to be in need of a consult. Table 2 below shows the number of trees in need of specific maintenance practices.

Table 2: Public trees in need of specific maintenance practices in Swanton Village.

Maintenance Practice	Number of Trees Needing Attention
Prune	94
Inspection of and/or removal of stem-girdling roots	29
Stake	0
Remove stake	1

Monetary Value and Ecosystem Services

The data was analyzed using i-Tree Streets software to determine the monetary value of ecosystem services provided by Swanton's public trees. The 449 trees provide a total of **$61,214** in total annual benefits by filtering air pollutants, mitigating stormwater runoff, sequestering carbon dioxide (CO_2), conserving energy, and increasing property values. On average, each tree offers $136 annually in savings or services. Figure 9 and Table 3 provide an overview of each ecosystem service provided by the Village's public trees. Energy conservation and property value increase are the most significant services provided by these trees by monetary value. The full i-Tree Streets reports for Swanton are available through VT UCF.

It is significant to note that the trees inventoried through this project are located on less than 2% of the total land area of the Town of Swanton – approximately .8 of a square mile (of 48 total square miles). Expanding the inventory to all Swanton ROWs and town-owned properties would increase these figures dramatically. It is also noteworthy that larger and long-living trees provide substantially more benefits than young, small trees; regular maintenance and care are needed to provide for urban tree health, longevity, and maximized urban forest benefits.

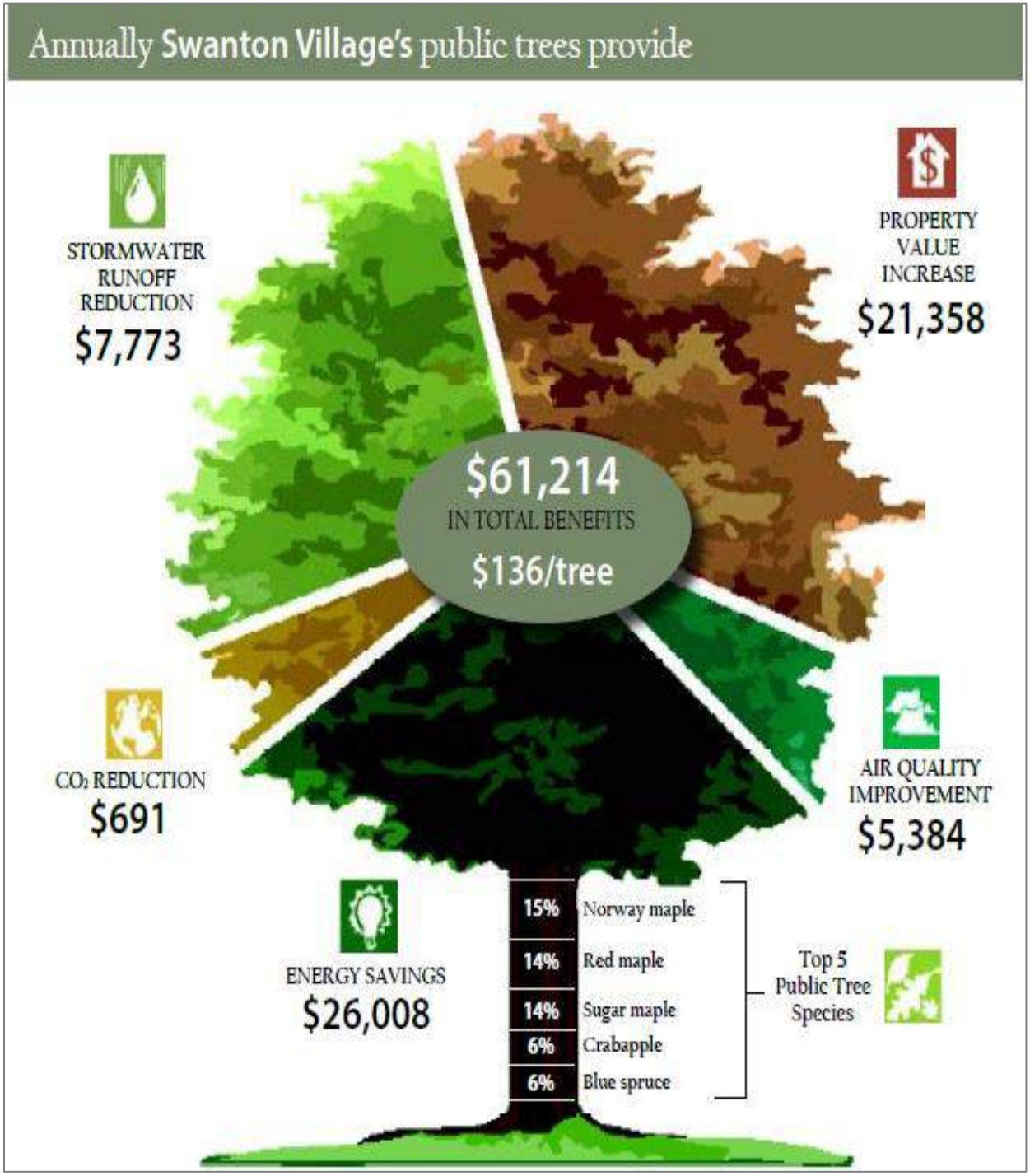


Figure 9: Summary of benefits provided by Swanton's public trees. Data generated through i-Tree streets and tree graphic concept courtesy of City of New York Department of Parks & Recreation.

Table 3: Ecosystem services and monetary benefits provided by Swanton Village's public trees.

Benefit Type	Benefit Description	Total Value of Trees Inventoried	Average value/tree
Energy conservation	Reduced natural gas use in winter and reduced electricity use for air conditioning in summer	$26,008	$57.92
Carbon dioxide	Annual reductions in atmospheric CO2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use. The model accounts for CO2 released as trees die and decompose and CO2 released during the care and maintenance of trees.	$691	$1.52
Air quality	Quantifies the air pollutants (O3, NO2, SO2, PM10) deposited on tree surfaces and reduced emissions from power plants (NO2, PM10, VOCs, SO2) due to reduced electricity use. Also reported are the potential negative effects of trees on air quality due to BVOC emissions.	$5,384	$11.99
Stormwater	Reductions in annual stormwater run-off due to rainfall interception by trees.	$7,773	$17.31
Aesthetic/other	Tangible and intangible benefits of trees reflected in increases in property values.	$21,358	$47.57
Stored carbon dioxide	Tallies all of the carbon dioxide stored in the urban forest over the life of the trees as a result of sequestration; *not an annual benefit but a cumulative benefit.	$9,926*	$21.44*
Totals		**$71,140* cumulative, $61,214 annually**	**$158.44* cumulative, $136 annually**

Swanton Full Canopy Assessment

As a complement to the public tree inventory, VT UCF's summer intern completed an i-Tree Canopy assessment for the inventory area in Swanton. i-Tree canopy is a free, easy-to-use online application that allows users to assess total tree cover (encompassing both public and private land) over a defined area based on randomly- generated map points and user-defined land cover types. The tool also assigns dollar values to the benefits associated with the overall tree canopy cover. The aim of this type of assessment is to help citizens and decision-makers better understand the existing and potential tree canopy in their community. Based on the

Swanton i-Tree Canopy assessment, approximately 26% of the Village is currently occupied by tree canopy cover (Figure 10). In consideration of the other land cover types detected through the 50-point assessment, Swanton could potentially increase its total tree canopy cover by an additional 37% on open lands of low-lying vegetation. Currently 20% of the Village area is occupied by buildings, wetlands, or water – not suitable for tree planting – but the remaining 18% is impervious surface (parking lots, playgrounds, roads and the ROW) and with strategic planning initiative, could be converted to canopy. In total, there is currently potential to increase overall tree canopy cover in Swanton by 55% (Figure 11).

Figure 12 compliments the i-Tree Streets analysis of the monetary value of benefits provided by Swanton's public trees by estimating the air quality benefits and corresponding monetary value for the full urban forest canopy. Of note is an estimated total of $469,486 in CO_2 storage and $18,620 in annual CO_2 sequestration value.

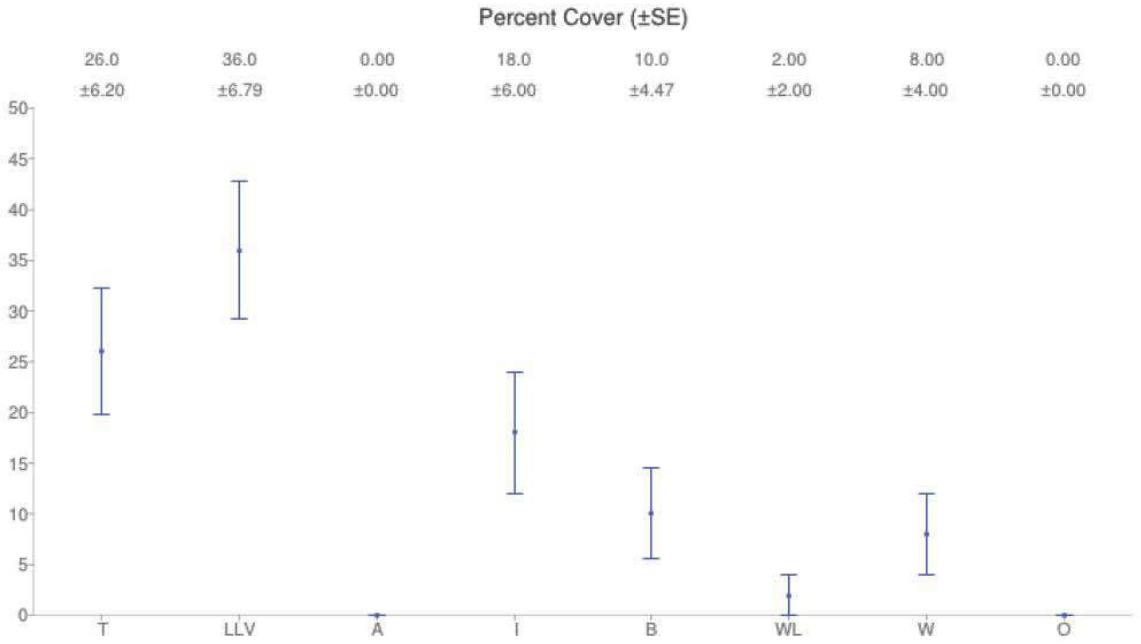
i-Tree

Tools for Assessing and Managing
Community Forests

i-Tree Canopy v6.1

Cover Assessment and Tree Benefits Report

Estimated using random sampling statistics on 10/31/14



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	13	26.0 ±6.20
Low Lying Vegetation	grasses	LLV	18	36.0 ±6.79
Agriculture	agricultural fields or farms	A	0	0.00 ±0.00
Impervious	streets, parking lots	I	9	18.0 ±6.00
Building	building	B	5	10.0 ±4.47
Wetland	marsh, wetland areas	WL	1	2.00 ±2.00
Water	Water	W	4	8.00 ±4.00
Other	Other land cover types (quarries, sand)	O	0	0.00 ±0.00

Figure 10: i-Tree Canopy assessment for Swanton Village based on 50 random points.

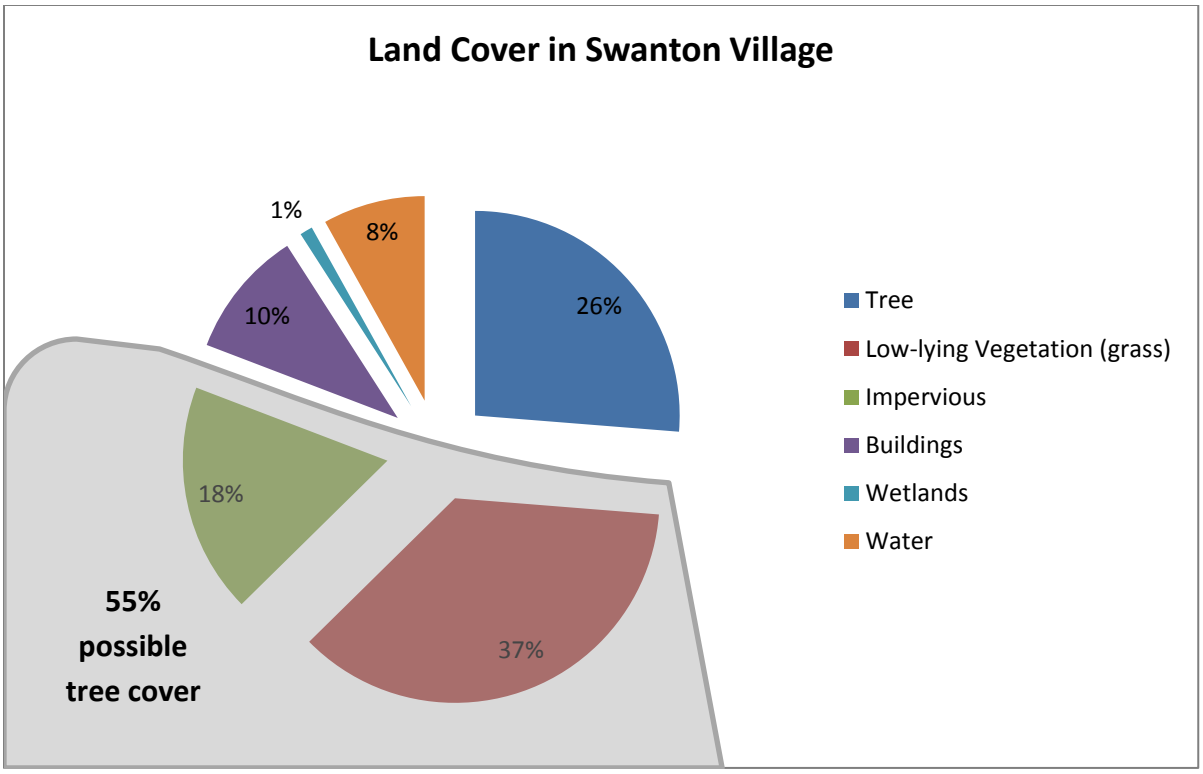


Figure 11: Land cover distribution in Swanton Village based on the i-Tree Canopy assessment.

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$7.37	±1.76	173.93 lb	±41.50
NO2	Nitrogen Dioxide removed annually	$12.69	±3.03	948.40 lb	±226.27
O3	Ozone removed annually	$661.05	±157.72	4.72 T	±1.13
PM2.5	Particulate Matter less than 2.5 microns removed annually	$1,366.52	±326.03	458.98 lb	±109.51
SO2	Sulfur Dioxide removed annually	$2.22	±0.53	597.66 lb	±142.59
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$479.91	±114.50	1.58 T	±0.38
CO2seq	Carbon Dioxide sequestered annually in trees	$18,620.74	±4,442.64	961.65 T	±229.44
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$469,486.86	±112,012.79	24,246.17 T	±5,784.79

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.902 @ $85.08 | NO2 4.917 @ $26.86 | O3 48.968 @ $140.47 | PM2.5 2.379 @ $5,975.67 | SO2 3.098 @ $7.45 | PM10 16.403 @ $304.43 | CO2seq 9,970.817 @ $19.43 | CO2stor is a total biomass amount of 251,395.359 @ $19.43*
Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.

Figure 12: Air quality benefits provided by the total canopy of Swanton Village, based on the i-Tree Canopy assessment.

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: maples) in a tree population and no more than 10% of one species (for example: sugar maple). Resistance to disease and insect infestation is one of the many reasons that diversity within the urban forest is of paramount concern. A more diverse forest will be more resistant to environmental stressors, and therefore remain healthy and resilient in the face of change. Furthermore, by maintaining higher diversity a community can prevent a rapid loss of canopy due to insect and disease issues.

In Swanton Village, 60% of public trees inventoried were in the maple (*Acer*) genus, which is three times the recommended representation within the community's urban forest. Specifically, Norway maple, red maple, sugar maple, silver maple, hedge and Amur maples (small, cultivated), and boxelder represent 15%, 14%, 14%, 6%, 3%, and 2% of the species diversity respectively. Norway maple is the most prevalent species in Swanton, and is now considered to be a non-

Components for Managing a Vibrant and Resilient Urban Forest

A successful urban forestry program requires a combination of organized leadership, comprehensive information about the tree population, dedicated personnel, and effective public relations. We recommend the following components for successful urban forest management.

Public Policies: A tree ordinance or policy provides authority for conducting forestry programs, defining municipal responsibility for public and private trees, passing regulations and setting minimum standards for urban forestry management.

Leadership: Define who is responsible for the oversight of the community forest, including formulating policies, advising, administration, management, representation and/or advocacy.

Partnerships: A well-managed urban forest takes the work of many. Seek strategic partnership to meet a shared vision. At a minimum the tree warden, a local advisory committee like a tree board or conservation commission and municipal staff (parks, roads, planning) should collaborate.

Responsibility: A clear understanding of which trees and areas will be managed is an important first step. Street trees, parks and village greens, cemeteries and schools are typical areas of municipal responsibility.

Assessment: A complete public tree inventory, including tree locations, species, condition, and management needs provides the necessary information to manage the resource. An inventory is the foundation to developing a strategic management plan.

Management Plan: A management plan provides a vision for the long-term management of the community forest. It should include strategies, budgets, and responsibilities for meeting that vision.

Staffing: The care of urban forest requires a certain skill set that can be found in-house with professional staff or through consultants. Whether creating a staff position for a certified arborist or urban forester, or contracting with them on an as-needed basis, professional assistance will have some of the greatest and most immediate impacts on a community forestry program.

Tree Canopy Goals: Consider a community's entire tree canopy to reduce loss and maximize gains over time by protecting undeveloped forest and impacts of land development, enhance the health condition and function of forests, and reforest through active replanting or allowing regeneration.

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. Maple trees are currently threatened by the invasive tree pest the Asian longnorned beetle (ALB); while this pest has not been discovered to-date in Vermont, the largest ALB infestation in North America is a little over 50 miles to our southern border in Worcester, MA. Ash trees (genus *Fraxinus*) are also threatened by an invasive tree pest, the emerald ash borer (EAB), but trees of the ash genera make up less than 3% of the public tree canopy of Swanton. This means that an infestation of EAB in Swanton would not significantly impact the overall urban forest density or composition. As of late 2014, EAB has not yet been detected in the state, but Vermont is surrounded on all sides by states or provinces with isolated infestations of EAB.

In addition to improving species diversity, striving for age class diversity is also important. The majority of trees in Swanton fall into the 6-24" size class, indicating that Swanton's public trees are reaching maturity. Only 15% of the public trees are under 6" in diameter, which means that there have not been many new trees planted in recent years. A well-distributed age structure is an important element of a strategically planned urban forest that will provide continued long-term benefits.

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 Swanton'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 or pests.
- Because of the high concentration of maple trees in Swanton Village, the additional planting of any maple trees (Acer) is not recommended.

- We suggest planting tree species that have been 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).
- Existing ash 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 Swanton 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 in both species composition and age structure, prioritize new plantings in the 59 identified vacant planting sites within the public ROW, at Swanton Beach, and at the Swanton Village Offices and develop a strategic planting plan.
- In planning for future tree plantings, consider obstructions above ground (power lines) and below ground, minimize grey infrastructure conflicts (sidewalks, streets, buildings, etc.) available soil volume, species mature size (height and spread), branching patterns, environmental tolerances (exposure, salt, and drought), and desired function when choosing species. For more information on site assessment and species selection, refer to the VT Tree Selection Guide at http://www.vtcommunityforestry.org/resources/tree-care/tree-selection.
- Encourage residents to plant trees on their properties to increase species diversity, age structure, and overall tree canopy benefits to the community.

Maintenance

The Swanton Village Manager requested data to be collected for several maintenance practices: pruning needs, inspection/removal of stem-girdling roots, staking, and removal of stakes. As shown in Table 2 (page 16), nearly a quarter of all public trees were identified as in need of pruning. 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 and regular mulching for soil health, moisture retention, and to protect 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 Swanton Village Manager and Swanton Tree Warden, for all public trees to promote tree health and reduce any threat to public safety.

Recommended action practices:

- Work with VT UCF to inventory the trees on the 11 sites and streets that were either partially completed or were not part of this inventory project (see Appendix A for full list). A comprehensive baseline inventory is important in order to establish a routine maintenance regime for all village-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.
- Use the map-based data from this inventory project to identify the 94 public trees that need to be pruned, the 29 public trees that show evidence of stem-girdling roots, and the one tree in need of stake removal.

- Encourage Swanton citizens to participate in VT UCF's Stewardship of the Urban Landscape training course to continue to build local capacity to care for and promote Swanton's canopy.

Urban Forest Health

Overall, Swanton Village appears to have a healthy population of public trees. Approximately 17% (76) of Swanton's public trees were either considered to be in "Fair" or "Poor" condition and 1 tree was determined to be "Dead". Concentrations of fair and poor trees were found on the Swanton Village Green, the Taylor Drive Green, and the Swanton Village Office complex and along Brown Avenue, Canada Street, Thibault Street and Second Street. There were 75 trees flagged to be revisited by a trained arborist or Village employee; 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 C for a map detailing the locations of the fair, poor, and dead trees in Swanton Village and a map indicating the location of the 75 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, and remove the one dead tree to increase overall urban forest health.

Recommended action practices:

- Send an ISA certified arborist to assess the 75 trees flagged for consultation in a systematic and timely fashion.
- Remove the one dead public tree (within the ROW, in front of 77 Grand Street).
- Closely monitor the health of the 15 public trees in poor condition and plan for their removal and replacement in the near future.

- Continue to monitor the health of the trees in good and fair condition and record any changes in tree health through a regular inventory cycle.

Assessment Tools

Using free i-Tree software developed by the USDA Forest Service, we were able to assess the value and potential expansion of Swanton's urban tree canopy. i-Tree Streets allowed us to determine the economic value of the ecosystem services provided by the 449 inventoried trees in Swanton Village. Swanton's public trees contribute about $61,000 annually through the benefits of air quality improvement, carbon storage, electricity and natural gas, aesthetics, and storm water control; on average, each tree offers $136 in service or savings every year. Combined with trees on private land – assessed by using the i-Tree Canopy tool – and their estimated air quality benefits, Swanton Village's urban forest is providing around half a million dollars in benefits through its ecosystem services. The trees of Swanton provide services 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. There are also numerous health benefits to trees. 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. and it saves $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 reduce 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 flow of precipitation.

Recommendation:

Use the information generated through the i-Tree Streets and i-Tree Canopy programs to promote investment in urban forest management and local stewardship.

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 Village of Swanton to understand, manage, and steward its urban forest. The recommendations outlined in this report are based on the LANDS interns' observations and data analysis combined with the experience and evaluation of VT UCF staff; they should considered by the Swanton Village Manager and the Swanton Board of Trustees based on long-term goals and vision, as well as capacity to implement. VT UCF will continue to be a resource as the Village moves its urban forestry program forward.

Sources

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Appendix A: Full Street and Site List for the Swanton Village Inventory

Street or Site Name	Public ROW (in feet)	Number of Trees	Number of Vacant Sites or Strips Identified
ACADEMY STREET	50	0	0
BLAKE STREET	50	1	1
BOSWORTH STREET***	40	0	0
BROADWAY STREET***	75	0	0
BROWN AVENUE	50	9	6
CANADA STREET	100 - 85 - 50	34	1
CHARLES STREET***	35	0	0
CHURCH ROAD	50	19	0
CHURCH STREET CEMETERY***	n/a	0	0
DEPOT STREET	50-70	1	0
DEWEY STREET	30	1	1
DUNNING STREET	40	1	0
FARRAR STREET	50	3	0
FERRIS STREET***	35	0	0
FERRY STREET	30	1	0
FIRST STREET	60	6	0
FLAT IRON PARK	n/a	5	0
FOUNDRY STREET	45	0	0
FOURTH STREET	35	9	1
FURMAN PLACE	50	5	0
GALLUP COURT	40	9	1
GRAND AVENUE	90-99	47	0
GREENWICH STREET***	60	0	0
JEWETT STREET	35	0	0
JONES COURT	50	1	5
KANE AVENUE***	40	0	0
KING STREET	40	0	1
LAKE STREET	50	11	3
LAROE STREET	40	1	0
LAVOIE AVENUE	40	0	2
LIBERTY STREET	50	5	3
LINDA AVENUE	50	13	5
MARBLE MILL PARK	n/a	19	0
MERCHANTS ROW	50	5	0
MIDDLE ROAD	66	13	2
NEW STREET	60	36	0

NORTH RIVER STREET	55	1	0
PIKE DRIVE	40	1	0
PINE STREET	45	5	2
PLATT STREET	50	4	0
RIVER LANE	20-30	2	0
SOUTH RIVER STREET	45	7	3
SCOTT STREET	60	1	0
SECOND STREET	49.5	21	0
SHORT STREET	55	4	0
SPRING STREET***	60	23	5
STEARNS COURT	50	2	1
SWANTON BEACH	n/a	8	1
SWANTON TOWN CLERK BLDG.	n/a	3	0
SWANTON VILLAGE GREEN	n/a	67	0
SWANTON VILLAGE OFFICES	n/a	8	1
TANNER MEMORIAL DRIVE	50	2	3
TAYLOR DRIVE	50	8	4
TAYLOR DRIVE GREEN	n/a	9	1
THIBAULT STREET	40	6	6
THIBAULT PARKWAY***	50	0	0
WEBSTER TERRACE***	30	0	0
WINTERS COURT***	40	0	0
YORK STREET	55	12	0
Total		***449***	***59***

*Streets and sites that were not completed, or only partially completed, in the summer 2014 inventory with the LANDS interns are indicated with by *** and shaded in grey.*

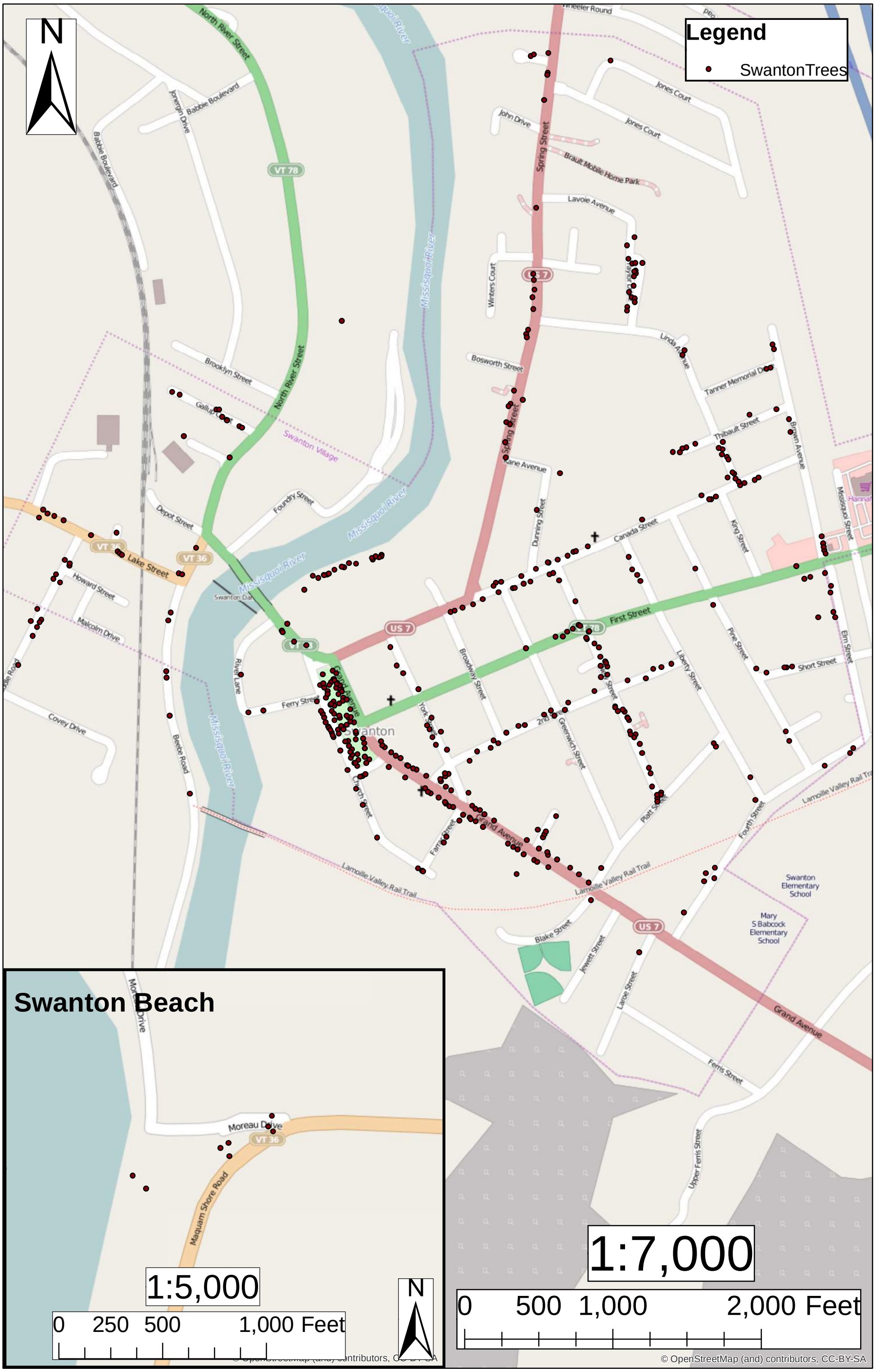
Appendix B: Complete Species List of Swanton's Inventoried Public Trees

Species	Number of trees	Distribution (%)
Norway Maple *(Acer platanoides)*	67	14.92
Red Maple *(Acer rubrum)*	65	14.48
Sugar Maple *(Acer saccharum)*	62	13.81
Crabapple *(Malus sp.)*	27	6.01
Blue Spruce *(Picea pungens)*	26	5.79
Silver Maple *(Acer saccharinum)*	25	5.57
Eastern Cottonwood *(Populus deltoides)*	20	4.45
Broadleaf Deciduous Misc.	15	3.34
Conifer Evergreen Misc.	12	2.67
Amur Maple *(Acer ginnala)*	11	2.45
Broadleaf Evergreen Misc.	11	2.45
Japanese Tree Lilac *(Syringa reticulata)*	11	2.45
Boxelder *(Acer negundo)*	10	2.23
Green Ash *(Fraxinus pennsylvanica)*	10	2.23
White Spruce *(Picea glauca)*	9	2.00
Bur Oak *(Quercus macrocarpa)*	6	1.34
Pine species *(Pinus sp.)*	5	1.11
Northern Red Oak *(Quercus rubra)*	5	1.11
Other Birch *(Betula sp.)*	4	0.89
Honeylocust *(Gleditsia triacanthos)*	4	0.89
Other Maple *(Acer sp.)*	4	0.89
Dogwood *(Cornus sp.)*	4	0.89
Other Spruce *(Picea sp.)*	4	0.89
Black Spruce *(Picea mariana)*	4	0.89
Other Oak *(Quercus sp.)*	4	0.89
Black Locust *(Robinia pseudoacacia)*	4	0.89
River Birch *(Betula nigra)*	2	0.45
Norway Spruce *(Picea abies)*	2	0.45
Swamp White Oak *(Quercus bicolor)*	2	0.45
Eastern Redcedar *(Juniperus virginiana)*	2	0.45
Linden *(Tilia americana)*	2	0.45
Littleleaf Linden *(Tilia cordata)*	2	0.45
Horsechestnut (*Aesculus hippocastanum)*	1	0.22
Northern Catalpa *(Catalpa speciosa)*	1	0.22
White Ash *(Fraxinus americana)*	1	0.22
Tulip Tree *(Liriodendron tulipifera)*	1	0.22
Common Chokecherry *(Prunus virginiana)*	1	0.22
Mountain Ash *(Sorbus americana)*	1	0.22
American Elm *(Ulmus americana)*	1	0.22
Other Elm (*Ulmus sp.)*	1	0.22
Total	*449*	*100.00*

Appendix C: Maps

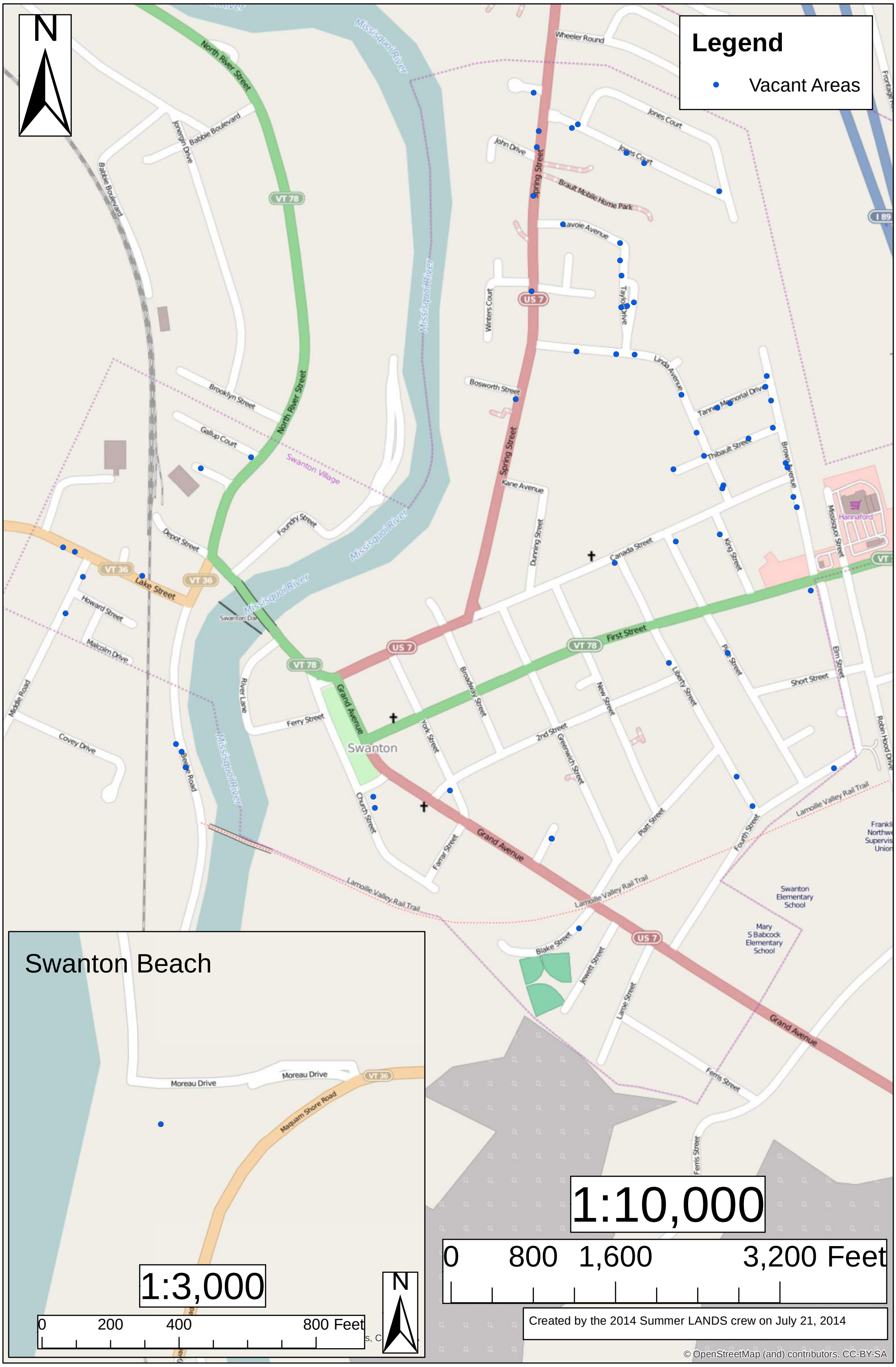
- All public trees inventoried in Swanton Village
- Potential tree planting locations within the ROW or on village-owned property
- Public trees by DBH in Swanton Village
- Trees requiring a consult in the public ROW in Swanton Village
- Public trees in “Good” condition in Swanton Village
- “Dead”, “Fair”, and “Poor” condition public trees in Swanton Village

All Trees in Swanton VT

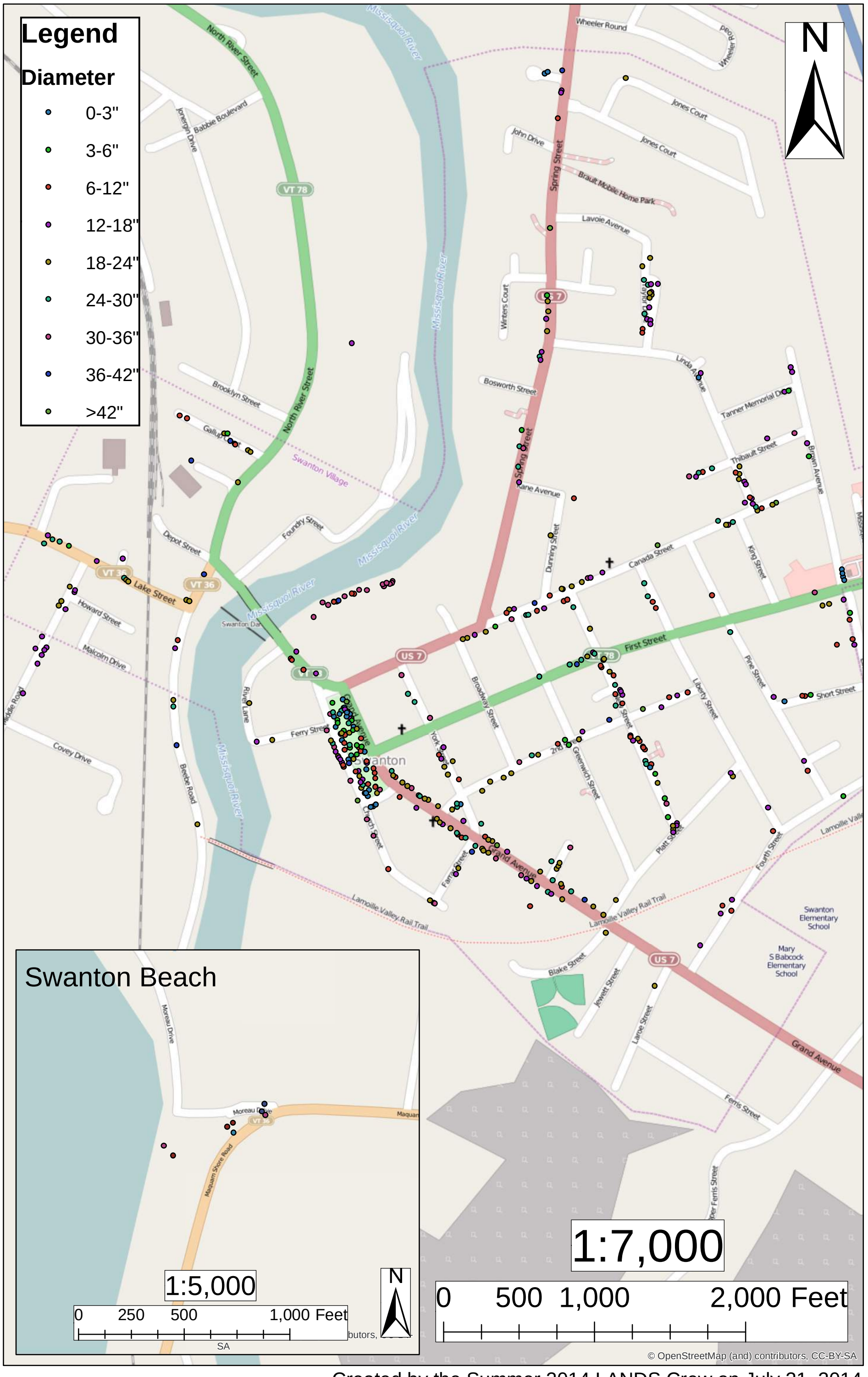


Created by the Summer 2014 LANDS Crew on July 21, 2014

Potential Tree Planting Locations in the Public Right of Way of Swanton, VT

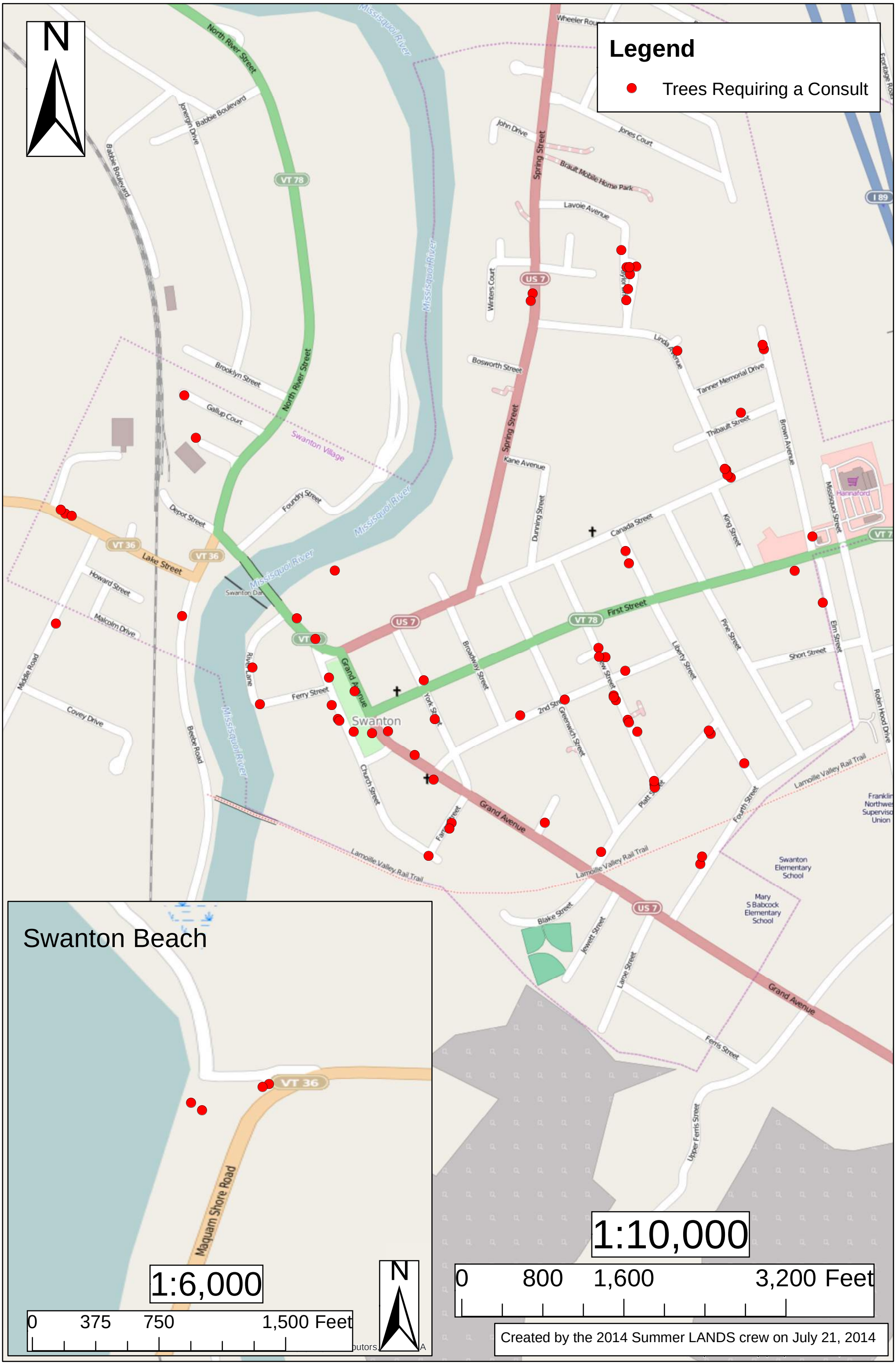


Trees by DBH in Swanton VT



Created by the Summer 2014 LANDS Crew on July 21, 2014

Trees Requiring a Consult in the Public Right of Way of Swanton, VT



Trees in Good Condition in Swanton VT

Created by the Summer 2014 LANDS Crew on July 21, 2014

Dead, Poor and Fair Condition Trees in Swanton, VT

Legend

Condition Class

- Dead
- Fair
- Poor

Swanton Beach

1:5,000

0 300 600 1,200 Feet

1:7,000

0 625 1,250 2,500 Feet

N

Text

Created by 2014 Summer LANDS crew on July 21, 2014