Identifying Impediments to Completing an Urban Forest Canopy Assessment in Municipalities in the State of Virginia

by

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Abstract

Tree canopy assessments help identify the extent and location of urban forest resources under management. Tree canopy assessments give a picture of what the urban forest resource looks like presently; and can be used to establish and track management goals for a municipality and quantify benefits being provided by the urban forest. Such an assessment can also help guide the most effective distribution of labor and resources. However, many municipalities in Virginia do not have canopy assessments and are unable to realize these benefits. To assess what impediments urban forestry professionals of small municipalities in Virginia are facing, we conducted a focus group meeting of experienced urban foresters via teleconference. Participants were asked about their perceptions and knowledge of tree canopy assessments. Participants had general knowledge of the benefits of an assessment, but generally lacked, or had varying degrees of knowledge of the methodologies for conducting an assessment. Participants expressed concerns on topics such as funding an assessment; communicating the value of an assessment to decision makers and citizens; and the use of volunteers in gathering information for a tree canopy assessment. Specific suggestions generated by the focus group to overcome perceived or real impediments were a website resource for urban forestry professionals co-sponsored by Virginia Tech and the Virginia Department of Forestry and coordinated support for the Tree Stewards Program at the state level to improve success using volunteers for urban forest assessment. In addition, participants agreed that a survey of urban forest decision makers from municipalities across the state would help Virginia Tech and the Virginia Department of Forestry better target outreach programs to meet municipal needs in urban forest canopy assessment.

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Introduction

A tree canopy is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. The canopy of all the trees found in a municipality is known as the urban tree canopy and is a useful metric for estimating the ecosystem services provided by an urban forest. The ecosystem services include shade, aesthetics, storm water abatement and many other environmental benefits. Many larger municipalities and counties (>80,000 population) are conducting tree canopy assessments in Virginia, either independently (e.g., Fairfax County), or in partnership with the Virginia Department of Forestry (VDOF) (e.g., Norfolk, Virginia). These assessments help answer the question of "What do we have?" for urban foresters. A tree canopy assessment provides information concerning the extent and location of the urban forest under management. American Forests, a nonprofit citizen advocacy organization for trees, recommends that municipalities located in the eastern United States have a combined tree canopy cover of 40% over available land (American Forests, 2010). Conducting a tree canopy assessment gives data of how much canopy cover a municipality has, where it is distributed, and often where potential planting spaces are located. A canopy assessment is essential for setting and achieving canopy goals. Although larger municipalities may have more resources for conducting such assessments, the benefits of a tree canopy assessment can be realized regardless of size of the municipality, and may be especially important in bringing public attention to the value of these benefits. Such recognition can positively influence funding for urban

forestry as occurred in the 1999 when Mrs. Betty Brown Casey saw a satellite image in the Washington Post describing the shrinking city tree canopy and decided to endow a new nonprofit organization, the Casey Tree Foundation (now Casey Trees) to help enhance Washington's urban tree canopy resource (American Forests, 2001).

While larger and more prosperous municipalities, such as Fairfax County, have detailed canopy and land use assessments, experience with smaller municipalities indicates they are not conducting tree canopy assessments without direct state assistance. Many of Virginia's smaller municipalities do not have an urban forester, an arborist, or a horticulturalist to manage their urban forest. In addition, they may have limited data management capabilities within their public works departments. The VDOF is currently working with municipalities across the state to assist them in assessing their urban tree canopy. However, funding is limited, and assessments must often be conducted multiple times in order to achieve long-term management goals. Therefore, it would be beneficial to identify impediments to undertaking canopy assessment in these smaller municipalities to better target educational and technical assistance programs within the state. Our objectives were to 1) make an initial identification of impediments to completing a tree canopy assessment in communities of less than 80,000 residents; 2) identify areas where more information is needed from municipalities to better understand their needs; and 3) make a preliminary action plan for obtaining this information and/or providing educational and technological resources to municipalities to improve their ability to conduct urban forest assessments in the future.

Canopy Assessment for Urban Forests

For many small municipalities the percent canopy cover provided by their urban forest is not a concern that reaches council chambers. Yet, this measurement has great value for both planning and managing the urban forest and for calculating the benefits and services it provides. For example, its value may further increase in the very near future if current interest in creating markets for carbon credits continues creating a situation where the measure of a municipality's carbon footprint may provide funding opportunities. In addition, urban forests are already being relied upon for their value in mitigating storm water and its associated issues such as increased erosion, pollution, and reduced downstream stream health. This subject is beginning to make in-roads into municipal planning and budgeting as regulatory requirements increase (EPA, 2005). But municipal governments are not always cognizant of the other benefits of trees.

Healthy, mature urban trees provide many other ecosystem services as well. Trees are valuable resources for carbon sequestration (Nowak, 2006). The role of trees in providing shade and cooling the urban environment is readily acknowledged by municipal residents (Lohr et al, 2004). The presence of trees in sufficient number can mitigate storm water runoff exacerbated by impermeable surfaces associated with streets, parking lots and roofs (Xiao, 2003). Furthermore, significant shade trees dispersed throughout a municipality can dampen the overall temperature increases commonly associated with urban environments (Nowak and Dwyer, 2007). This temperature increase is known as the heat island effect and is the result of pavement and structures re- radiating acquired solar energy. Heat islands can increase ground

level ozone, harming human health. Trees can also improve air quality in urban environments by intercepting particulate pollutants from the atmosphere (Nowak et al., 2006)). Trees provide additional benefits to municipalities through increased property values, providing shade for recreation and socialization, and buffering of wind and noise.

All of these benefits are available through a healthy urban forest ecosystem. This may consist of trees in residential yards and common areas, parks, public spaces, commercial areas, as well as trees along streets and roads. The general public may not perceive this to be a forest in a traditional sense, although, from a management perspective this is very much a forest ecosystem. It requires planning, funding, and management to remain healthy and sustainable.

The Value of Canopy Assessment for Urban Forest Management

The urban forest can be understood in terms of value, function, and structure. The examples above show the value and function of the urban forest. The structure of an urban forest consists of location, composition, and extent. Location is a function of tree placement and land use. Composition is concerned with tree species, size and condition. Extent is the tree count and canopy cover. One measure of extent, canopy cover, is ideal for evaluating the magnitude and value of the ecosystem services derived from the urban forest. Knowledge of the extent of an urban forest is also important from a management perspective. A canopy assessment can provide crucial information to those tasked with managing the urban forest, allowing municipalities to reap greater

benefits from their urban forest. Information regarding distribution of the canopy, and potential planting spaces can direct efforts of new planting of trees. For example, an assessment can provide data on how much stormwater retention capacity is in the urban forest, and what would be the cost to the city if this runoff was handled through the construction of infrastructure. It is essential to answer two fundamental questions of urban forest management, namely "What do we have?" (resource assessment); and "Where do we want to go?" or "Are we getting what we want?" (management goals). Completing an assessment of canopy cover and subsequently setting an urban tree canopy goal is a key goal to achieve a sustainable forest, where the ecological, social and economic functions are maintained for the long term. Once a tree canopy goal is established, management and work plans can also be employed to establish the priorities of protection, planting and maintenance necessary to achieve of long term benefits.

Two Approaches in Assessment

To determine an appropriate assessment approach, a municipality must consider what its information needs are, and the scale and scope of urban forest planning. These goals are often laid out in the municipal master plan. In addition, available funding and time to complete the assessment will influence which approach is best suited. What is appropriate for one municipality may not be appropriate for another. There are two common methods for conducting a canopy assessment, namely a "top down" approach and a "bottom up" approach. It may be helpful to think of the "top down" approach as one where you are looking at the forest; and the "bottom up" approach where you are

looking at a tree. There are several approaches to accomplishing a canopy assessment (Table 1). The best choice of assessment depends partly upon the intended use.

Table 1. Assessment methods of the two approaches "top down" and "bottom up"

Assessment Method	Advantages	Disadvantages	Cost
Manual Photo Interpretation - Reconnaissance Level Inventory Using Dot Grid	Use of free data available --- Cover assessment can be done quickly --- Accuracy can be increased by adding more data collection points --- Can produce sub maps, i.e. political, neighborhood --- Can use leaf-on or high resolution leaf-off imagery	Does not produced a high quality map --- Increased probability of operator error --- Requires significant manual input --- Difficult to efficiently repeat process in the future --- Accuracy issues	Purchase of image, if free one not available --- Contract photo interpreter for analysis and report --- Increase costs may be associated with higher degree of accuracy
Multispectral Image Analysis	High resolution image (1 meter or better) --- Good estimates of coverage & location Integrates into GIS --- Can locate potential planting sites --- Multi-spectral equals lower processing costs	More technical --- Licensing restrictions of data --- Requires technical expertise --- Larger data files, may require high computing power --- Requires leaf-on imagery	Imagery may have to be purchased --- May have to pay license fee to image provider --- Contract remote sensing technician to process image and create report --- Weather may cause cancellation/delay of acquisition – additional charges may be incurred

Table 1. Assessment methods of the two approaches "top down" and "bottom up"

Assessment Method	Advantages	Disadvantages	Cost
LIDAR	High accuracy – can determine height of trees; resolution of 1 meter or better --- Collect data in wide range of conditions --- Data is collected quickly, large areas covered in shorter time	Not many firms offer technology --- Large amounts of data require complex processing --- Lidar imagery not readily available in all areas yet.	Technician qualified in this technology for interpretation and analysis report --- Data and processing costs
i-Treetools and utilities	Can use complete or random inventory --- Accuracy can be increased by adding additional sample plots --- Provides dollar value and other benefits --- Trained volunteers can be enlisted	Labor intensive --- Does not produce a map --- Requires specialized software tools	If PDAs are used for collection of data instead of written on forms and manually entered --- Salary for technician to prepare reports Labor costs can be reduced by using volunteers to collect data, otherwise labor expenditure is incurred

In the "top down" approach, an image is acquired through digital aerial photography, LIDAR, or satellite imagery. Digital aerial photography is a process where a very high quality photographic image is acquired on a cloudless day. The photograph is interpreted by a qualified technician for the purpose of assessing the percent of tree canopy cover, the canopy's distribution, and available potential planting spaces. LIDAR (**Li**ght **D**etection **A**nd **R**anging) is an optical remote sensing technology that measures

properties of scattered light to find range and/or other information of a distant target. LIDAR can create a very accurate image of the urban forest with a resolution of less than one meter (Popescu et al., 2003); however, LIDAR can extract crown density information to a level of 18 cm (Chen et al., 2006). Multispectral imagery is an image acquired by a satellite or airplane. These images are captured to take advantage of information from the visible and nonvisible spectrum of the electromagnetic spectrum. Features on the earth's surfaces reflect this energy according to a unique signature. The data provides information that can be used to classify land use and land cover. The satellite imagery approach is technically complex and can be very time consuming in that there are multiple steps involving levels of processing.

A simple and perhaps most rudimentary example of a top-down approach would be to use Google Earth. Google Earth provides current images at an average of 15 meters resolution; however, in Virginia the images are at 1 meter (Personal contact, Dr. John McGee). This requires being able to perform photo interpretation, and may have to be subcontracted to a firm specializing in manual photo interpretation. This approach is probably most efficiently applied through a reconnaissance level inventory of tree canopy.

An approach in the "top down" category using multispectral imagery is the work being done by the University of Vermont Spatial Analysis Laboratory. This is a current remote sensing project that provides data that can evaluate current and future potential tree canopies for some selected municipalities. Virginia Tech is working in collaboration

with the University of Vermont, the United States Forest Service and the Virginia Department of Forestry to complete a statewide canopy assessment of major urban areas. Municipalities that have participated in this program to date are listed in Table 2. The "top down" approach may be useful for many municipalities, and the techniques available offer some options in expenditure.

Table 2. Municipalities in the State of Virginia that have completed an Urban Tree Canopy Assessment.

Municipality	Population	Area (sq. mi.)
Arlington County	217,483	25.87
Blacksburg	39,284	19.00
Charlottesville	40,315	10.00
Chesapeake	220,560	340.00
Fairfax County	1,037,605	395.04
Fredericksburg	23,193	10.52
Leesburg	37,476	11.00
Lexington	6,901	2.49
Lynchburg	67,720	49.00
Manassas	36,638	9.00
Norfolk	233,333	53.73
Purcellville	3,584	2.60
Radford	15,859	9.86
Roanoke City	91,552	42.00
Salem	25,462	14.59
Vinton	7,782	3.20
Virginia Beach	435,619	248.00
Winchester	26,322	9.33

College of Natural Resources. (2010, May 10). Urban Tree Canopy Analysis of Virginia Localities. Retrieved from http://www.cnr.vt.edu/gep/VA_UTC.html
United States Census Bureau. (2010, May 12). Demographic Profiles for Places in Virginia. Retrieved from http://www.censtats.census.gov/data/VA/05051840.pdf

The second approach to a tree canopy assessment is known as the "bottom up" approach. This involves gathering information about individual trees on the ground at specific sampling sites or, if it is manageable, through the entire municipality. The U.S. Forest Service has developed the UFORE model (Nowak and Crane, 2000), and the i-Tree

suite of software to partly automate this approach. For example, with i-Tree Eco, sample plot data or complete tree inventories can be developed and subsequent data concerning canopy cover, structure and location as well as the value of the ecosystem services provided by the urban forest can be generated. One significant benefit of this approach is that a host of urban forest condition and composition parameters can be accurately assessed at the same time, providing a rich resource for urban forest planning and management (Wiseman and McGee, 2010).

Canopy Assessments in Virginia: Defining the Problem

In spite of the great advantages of urban tree canopy assessment, the majority of Virginia municipalities do not have a current canopy assessment. Impediments to a municipality to conducting a tree canopy assessment are varied. Some may be real, i.e. actual impediments such as a lack of funding, or qualified staff. Others may be perceived, such as the belief that a canopy assessment is too difficult or other ideas conceived based on a lack of knowledge or information. In order to determine what these impediments are, we conducted a focus group meeting of urban forestry professionals in Virginia. Our objectives were to identify impediments, consider a strategy for getting more information from a broader sector, and make recommendations to remove or reduce these impediments.

Focus Group with Urban Forestry Professionals

To ascertain the opportunities and challenges for implementing a tree canopy assessment, a conference call was held with urban forestry professionals in December 2009. A professional urban forester, an arborist, a city horticulturalist, and the head of a volunteer organization in urban forestry were surveyed for their responses to questions of real and perceived impediments. An agenda was provided ahead of time to direct the conversation and in the preparation of notes and information to share with the group. The discussion centered around two themes: ***impediments*** and ***opportunities***.

Impediments to Canopy Assessment

Those participating were asked of the awareness and understanding of the benefits of canopy assessment. Most knew of municipalities completing an assessment. Some had colleagues in municipalities where an assessment had been completed and all were of the opinion that there were many benefits to be had in completion of a tree canopy assessment. The real issue that was vocalized was the public's and the decision makers' understanding and awareness of the benefits from conducting an urban tree canopy assessment. It was stated that there was a real concern to demonstrate the value and need of such an undertaking to the public. The group was strongly opinionated in regard to articulating the consequences of managing the urban forest without a clear understanding of the resource. It was brought to the table that the fiscal decision makers may not have a clear understanding the subject, and this could be detrimental to the collective efforts of urban forestry management. It was noted by some that there is often a communication disconnect between city council and city

administration that added to the difficulty in overcoming this particular challenge. Educating the public and the fiscal decision makers was seen as very crucial.

When the topic turned to methodologies for assessing urban tree canopy, most of the participants stated that they knew some of the general ideas of how an assessment could be carried out; however, knowledge of actual steps to be taken and what is involved to get the process started was obviously not known to those who have not participated in the UTC program of the Virginia Department of Forestry. The perception and opinion of some in the group was that the technology used in an assessment seemed intimidating; some were confident that they would be able to use it if only there would be a good tutorial. Others responded that they were more familiar with the bottom up approach of the i-Tree program. Some were aware of the assessment program taking place at Virginia Tech and through the Virginia Department of Forestry, but getting access to the data acquired or interpreting the information, again, in the words of one participant would be "very challenging."

Participant Perceptions of Impediments

Participants perceived that though they knew the benefits of an assessment, lack of knowledge of how to carry out an assessment could dissuade decision makers and make them believe an assessment was not really necessary. If this perception is well founded, funding for an assessment from municipal decision makers would most likely be tied to the urban forest professional's ability to communicate the available assessment approaches, their pros and cons, and the cost associated with each

approach. It was apparent that the current funding environment has added to the already competitive atmosphere associated with the municipal budget process and for urban forestry professionals a thorough understanding and working vocabulary of urban tree canopy is absolutely a requirement.

When the question of, "Were urban foresters aware of resources to help them conduct an assessment?" was put to the group, the response was of a mixed awareness. Some of the group had explored what information was available on the internet, some had spoken to other professionals in the field and had an anecdotal awareness, and still others had little or no information of what resources were available. Clearly the participants and others they knew were overwhelmed with increasing workloads, reduced staff and funding and had not had the time required to do an in-depth internet or resource search that would assist them in the undertaking of a canopy assessment. This theme ran through the entire teleconference.

The stresses related to the current work environment caused the subject of a general lack of guidance from the Virginia Department of Forestry in many other areas to come to the table. There was a palpable sense of frustration in the remarks of the participants. One respondent remarked, "We need a go-to source, but we have none to go to." Most agreed that if there could be some type of clearinghouse of information and resources it would move to be invaluable to all urban foresters, city arborists and horticulturists'. There was a general consensus in perception that the Virginia Department of Forestry was not involved at the level that was needed or required to

achieve the objective of having all, or even a majority of, Virginia municipalities engaging in ongoing canopy assessment. At this point it became clear that a resource that would facilitate the needs of urban forestry programs was not only needed but clearly desired by the participants.

Opportunities for Canopy Assessment

We moved the conversation from the subject of challenges to one of opportunities. Through the conversation to this point, the teleconference facilitators had offered ideas and remarks in response to lack of information or resources; however, now real opportunities were discussed. On the subject of funding, most participants concluded that future funding would be more limited than it is currently. The remark was made that the urban forestry program at nearby Roanoke was cut by 50%; and the remaining arborists are scheduled to spend almost as much time mowing grass as pruning trees. Some of the ideas that were considered included the search for grant funding. Again, the subject of time to search for grants and the additional time to explore grant funding and writing was highlighted as an impediment. The group concurred again on the need for a resource that would provide information and guidance.

The subject of using volunteers brought a mixed response. Some were unaware of the Tree Stewards Program, while other had a negative experience with volunteers in the program. One participant reported their best success was the use of prison labor. Still others had very positive remarks for their experience with The Master Gardener

Program. The Master Gardener Program is organized by Cooperative Extension in the United States. This program provides avid gardeners many hours of intense horticulture training. In return they 'pay back' local Extension agents through volunteerism, often fielding calls from homeowners and conducting educational programs. Some had used neither programs but had instead worked successfully with the Master Naturalists. The Master Naturalist Program "is a statewide corps of volunteers providing education, outreach, and service dedicated to the beneficial management of natural resources and natural areas within their communities. Interested Virginians become Master Naturalists through training and volunteer service." (http://www.virginiamasternaturalist.org/) All in the group commented that there was no real leadership or unified approach in the use of volunteers in urban forestry and guidelines and organization on the state level would be very valuable.

Resolving Impediments to Canopy Assessment

Numerous suggestions for overcoming impediments to conducting canopy assessments were suggested. Here we summarize the suggestions for resolving impediments that were commonly agreed upon by the group (see Table 3 for summary). The subject of changing opinions in municipal decision makers via an advisory board or other grass roots initiative to help overcome issues of funding and increasing the success of using volunteers was brought as a subject of discussion. It was deemed extremely useful to have citizen stakeholders' advocate on behalf of urban forestry issues and concerns to city or town councils. By having the community speak directly to council, the message that the community values the work being done by the urban

forester is important to the taxpayer is strongly conveyed. One of the facilitators made the observation that a consistent and repetitive message would be the only successful one. Comments were along the lines that advisory boards could prove valuable, yet the time it takes to bring people up to speed and to properly educate a new member, not only on the basics but current issues and projects, caused some in the group to comment, "It just isn't working as it should." Others felt strongly that the only real hope of successful political lobbying would be through the use of citizen advocates whether on an advisory board or as an independent group that was willing to speak at the open forums allowed to citizens at council meetings. Some reported their greatest success in this realm.

There was no common approach to working or establishing an advisory board and there was at least one comment to the effect that it would be much appreciated if there was a manual of training for tree commissioners or advisory board members. Again, it was noted that there was a sincere lack of easily accessed resources for the urban forestry professional. A few commented that an opportunity for someone at the state level to help in these areas was again lost or overlooked. This part of the teleconference highlighted an important area that is of great concern to the urban foresters, and their desire for additional state assistance.

It was clear that the group was looking for guidance on a state level that was not readily available. The idea was put forward that perhaps Virginia Tech could create a website tool box as a resource for urban forestry professionals. This idea was

enthusiastically received by the entire group. The idea was further explored in discussion and as a result of the input of all participants the following suggestions resulted.

Virginia Tech and the Department of Forestry would sponsor and co-manage a website that would provide information and resources to aid, not only in the area of tree canopy assessment, but in several other areas that could be expanded as needs arose. These areas would include, but not be limited to, the following: political tools to handle the challenges dealing with city councils and city administrations; fiscal tools to aid in seeking traditional and nontraditional funding; technical tools to provide guidance to current and emerging technology; volunteer tools to seek out, manage, and sustain individuals and organizations willing to give of their free time; and a tree ordinance database that provides users all of the current municipal ordinances across the state of Virginia.

State level oversight of the Tree Stewards program as occurs in the Master Gardener program. This is important because volunteers of the Tree Stewards program can be utilized in the "bottom up" approach to gather data. It was noted by some of the participants that the quality of the volunteers in the Tree Stewards program was low, and by having state oversight of this program, there will be a more cohesive approach in recruitment, training, and retention of high quality volunteers.

A statewide survey of urban forestry professionals to be conducted to ascertain whether the conclusions and ideas generated from this teleconference have validity. A

sample of such a survey is included here as a starting point. This survey (Appendix One) conducted through the auspices of Virginia Tech could be emailed to perspective candidates from an existing database. The survey would be preceded by a short introductory letter (Appendix Two). The use of a follow up letter could additionally be used for slow responders.

The data generated by such a survey would provide useful information regarding not only impediments in conducting a tree canopy assessment but additional challenges as discussed by the group could be determined to be common or universal throughout the Commonwealth of Virginia. This data could provide the necessary impetus to establish a statewide resource to provide assistance to municipalities across the Commonwealth. If the need is as significant as those participating in the teleconference have testified to it being, the need is very great indeed.

Table 3. Suggestions generated by a focus group of urban forestry professionals in Virginia for assisting Virginia municipalities of fewer than 80,000 residents in conducting urban forest assessments.

Impediment	Suggested Course of Action
Lack of ready resources concerning tree canopy assessment and multiple areas of UF management	Information and resource website co-sponsored by Virginia Tech and the Virginia Department of Forestry on such subjects as tree canopy assessment, educating decision makers, citizen advocacy, grant funding opportunities, volunteer management, current and emerging technology
Inconsistent training and quality of Tree Stewards	State level coordination of Tree Stewards program modeled on the Master Gardener Program
Lack of information concerning characteristics of municipalities lacking canopy assessments and extent of impediments	Conduct a detailed survey of urban forest decision makers in municipalities with fewer than 80,000 residents in Virginia

Conclusion

There are many challenges facing urban forestry in Virginia today. Educating constituents and decision makers on the importance of proper funding of urban forestry; communication disconnects between municipal management and city councils; and conserving tree canopy cover are just a few. Certainly, the economic crisis the nation is currently experiencing is exacerbating all challenges in urban forestry; however, urban forestry professionals must meet these challenges and continue to manage their forests with every possible tool available to ensure a sustainable forest resource. Urban tree canopy assessments will provide necessary information in the context of resource assessment. Resource assessment is necessary to the establishment of management goals and the development of management plans for the urban forest. It is clear from the teleconference that there are real and perceived impediments to conducting a tree canopy assessment. The teleconference highlighted several needs facing the urban forestry professional, and these needs could be common to many municipal foresters throughout the Commonwealth. Due to the small size of the focus group, we recommend a statewide survey be undertaken to clarify the perceptions and needs of Virginia's urban forestry professionals in relation to urban forest canopy assessment. This information could be used to better target outreach and educational efforts in order to facilitate the changes necessary to encourage small municipalities to undertake tree canopy assessments.

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Appendix One: Proposed Survey

Survey Questions

1. What job title best describes your position? (check only one)
   - ❑ Urban Forester
   - ❑ Public Works Director
   - ❑ Arborist
   - ❑ Parks & Recreation Director/Supervisor
   - ❑ Horticulturist
   - ❑ Engineer
   - ❑ Volunteer
   - ❑ Other _____

2. What department oversees your budget?
   - ❑ Public Works
   - ❑ Urban Forestry is a standalone department/section
   - ❑ Parks & Recreation
   - ❑ Planning & Engineering
   - ❑ Other _____

3. Are you employed by a:
   - ❑ County
   - ❑ City
   - ❑ Town
   - ❑ Other _____

4. What is the size population you serve?
   - ❑ Less than 5,000
   - ❑ 5,000 – 10,000
   - ❑ 10,000 – 15,000
   - ❑ 15,000 – 25,000
   - ❑ 25,000 – 35,000
   - ❑ Between 35,000 – 50,000
   - ❑ Greater than 50,000
   - ❑

5. Are you managing trees on: (check all that apply)
   - ❑ municipal parks
   - ❑ medians
   - ❑ public squares
   - ❑ residential street right of ways
   - ❑ downtown/urban streets
   - ❑ grounds of city buildings
   - ❑ riparian areas
   - ❑ monuments/cemeteries
   - ❑ other _____

6. Do you what an urban tree canopy assessment is?

   - ❑ Yes
   - ❑ No

7. If yes, are you knowledgeable about the tools, methods, or system approaches of canopy assessments?

   ❑ ❑ ❑ ❑ ❑

   Less so Very

8. Do you believe that there is value in an urban tree canopy assessment or inventory?
   - ❑ Yes
   - ❑ Neutral
   - ❑ No

9. Do you believe that an urban tree canopy assessment or inventory would be effective in communicating the value of the urban forest to the decision makers that control your budget?
   - ❑ Yes
   - ❑ No

10. Do you have the necessary tools to relate the benefits and costs of trees as compared to other government services seeking funding?
    - ❑ Yes
    - ❑ Don't know
    - ❑ No
    - ❑

11. Would you be better able to advocate for the urban forestry in your community if you had an urban tree canopy assessment?
    - ❑ Yes
    - ❑ Don't know
    - ❑ No

12. Do you have educational program to help the citizens understand the value benefit and cost of your community's urban forest?
    - ❑ Yes
    - ❑ No
    - ❑

13. If a resource were available to you that provided either guidance or actual technical advice, how important would that be to the goals and objectives of your program? (short answer)

Appendix Two: Letters for Proposed Survey

Survey Letter

March xx, 20xx

Dear Urban Forestry Professional,

In order to determine possible impediments to conducting an urban tree canopy assessment and inventory, we are surveying professionals like you. Please complete the attached survey and return it with the enclosed stamped envelope. The results of this survey will be made available to you once the data has been processed into a readable format.

We would appreciate you taking a few minutes to complete the survey. We hope that the information that results from this survey will be beneficial to you and other professionals in urban forestry.

Sincerely,

Follow-Up Letter

March xx, 20xx

Dear Urban Forestry Professional,

If you have not completed the attached survey concerning impediments to conducting an urban tree canopy assessment, please take time to do so. Your participation is greatly esteemed and needed.

The results of this survey will be made available to you once the data has been processed into a readable format.

Sincerely,

Appendix Three: Urban Tree Canopy Assessment Glossary

Active Sensor An active sensor is a measuring instrument that generates a signal, transmits it to a target, and receives a reflected signal from the target. Information concerning the target is obtained by comparison of the received signal with the transmitted signal. Radar systems used to track airplanes are an example of an active sensor.

Bottom-Up Canopy Assessments Bottom-up approaches uses data collected on the ground, frequently a plot-based sampling scheme to measure tree canopy cover. In this approach, the amount of tree canopy cover that falls within study plots is extrapolated and taken to represent the urban tree canopy cover as a whole. This on-the-ground method may be most appropriate for very small communities, such as a homeowner's association or a school district's properties. Plot data can be collected using the US Forest Service's i-Tree tools and methods at www.itreetools.org.

Chesapeake Bay Program (CBP) The Chesapeake Bay Program (CBP) is a partnership between federal and state agencies, non-profit organizations, and academic institutions whose aim is to protect and restore the Chesapeake Bay.

Chesapeake Executive Council A legislative body serving Maryland, Pennsylvania, and Virginia. The Executive Council establishes the policy direction for the restoration and protection of the Chesapeake Bay and its living resources. A series of Directives, Agreements and Amendments signed by the Executive Council set goals and guide policy for the Bay restoration. The CEC consists of the Governors of Maryland, Pennsylvania, and Virginia, the Administrator of the U.S. Environmental Protection Agency, the Mayor of the District of Columbia and the Chair of the Chesapeake Bay Commission.

Color Infrared (CIR) An example of multispectral data that includes part of the visible light spectrum as well as the near infrared. CIR is especially useful for vegetation mapping.

Ecosystem Services The benefits that people obtain from ecosystems. These benefits may be environmental, social, or economic. Examples of environmental outcomes include the protection of streams, reduced stormwater runoff, reduced ozone concentrations, and increased carbon sequestration. Social outcomes may include improved human health, buffers for wind and noise, increased recreational opportunities, and neighborhood beautification. Economic outcomes can include reduced heating and cooling costs and increased property values.

Existing UTC Any piece of land in the city that was covered by UTC at the time of satellite data acquisition.

Geographic Information Systems (GIS) Acronym for ***geographic information system***. An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed. (ESRI GIS Dictionary, http://support.esri.com)

IKONOS A commercial satellite that collects high-resolution imagery at 1- and 4-meter resolution. It offers multispectral (MS) and panchromatic (PAN) imagery. IKONOS launched on September 24, 1999, and provides imagery beginning January 1, 2000. Imaging, Inc. distributes IKONOS imagery under the product name CARTERRA.

LIDAR Light Detection And Ranging sensors are active sensors that collect extremely detailed elevation data by way of a laser. By emitting pulses from the laser, then sensing the time it takes for the pulse to return, the height of objects on the ground can be inferred. A relative surface DEM generated from LIDAR data can greatly complement imagery when performing a UTC assessment as it allows for features that have similar spectral and textural properties, to be differentiated based on height. LIDAR can be particularly useful in separating trees from shrubs and buildings from parking lots.

Manual Interpretation Human interpretation is generally considered the most accurate method of extracting features from imagery; however it is extremely time consuming.

Multispectral Data Data that spans several parts of the EM spectrum is referred to as multispectral data. Color infrared (CIR) imagery is an example of multispectral data. It displays light from part of the visible spectrum as well as near infrared (NIR).

Near Infrared (NIR) Having a NIR (near infrared) band can assist in distinguishing tree and vegetation types (broadleaf vs. conifer vs. grass), impervious surface types (concrete vs. asphalt), and other features (forests vs. forested wetlands). NIR can also be used to assess vegetation condition. This makes NIR data invaluable for natural resource management.

Passive sensor Passive sensors record waves of electromagnetic (EM) energy that are either emitted or reflected from an object.

Possible UTC Where is it biophysically ***feasible*** to plant trees? This is the first step in the assessment process. It is not concerned with costs, logistics or the fact that tree planting may not be appropriate or desirable in some locations. For the Baltimore UTC assessment, all land that was not covered by water, a road, or a building was considered a "possible" planting location.

Potential UTC Where is it economically ***likely*** to plant trees? Which areas have regulatory constraints that conserve tree cover or have incentive supports for adding tree cover? Which areas are most cost-effective for achieving water quality or other goals?

Preferable UTC Where is it socially ***desirable*** to plant trees? For example, where will tree cover make neighborhoods more attractive? Where will tree cover address other issues such as cooling and cleaning the air?

Radiometric Resolution Radiometric Resolution is the number of brightness levels that the remote sensing technology can sense. The higher the radiometric resolution, the better the sensor will be able to distinguish objects with similar spectral properties. Most remote sensors, such as Landsat, yield 8-bit data (28) where

each pixel has a possible value of 0-255. Newer sensors are capable of collecting data at a much higher resolution. For example, the IKONOS and QuickBird satellites gather 11-bit (211) data, allowing for improved feature recognition when compared to traditional 8-bit data.

Resolution see *Spatial Resolution, Radiometric Resolution, Temporal Resolution,* and *Spectral Coverage*

Riparian Zone This is the area of vegetation around streams. In less urbanized systems, the riparian zone is extremely important for water quality. This area of vegetation captures and processes pollutants before they can make it into surface waters. In urban areas, however, riparian zones are often less effective at removing pollutants. One reason is that urban streams tend to be deeply incised, causing the riparian zone to be disconnected from the stream below. Secondly, the streams in many urban areas have been functionally replaced with storm sewers.

Spatial Resolution Spatial Resolution is the "pixel size" associated with the data. For reference, it generally takes at least 4 pixels to identify a feature. So, while Landsat imagery, with its 30 square-meter resolution, may be adequate for measuring large areas of intact forest it will do a poor job of identifying street trees in urban areas. This is why the Chesapeake Bay Guidelines suggest a minimum resolution of one-meter or better. As spatial resolution increases so does the storage size of the data.

Spectral Coverage Spectral Coverage is another consideration for data acquisition. Certain features and properties of land cover may be more distinguishable in different bands of the electromagnetic spectrum. For instance, the inclusion of a NIR (near infrared) band is optimal for classifying vegetation data as the majority of EM energy reflected by vegetation is in the NIR portion of the spectrum.

Stormwater Runoff Surface water that fails to infiltrate the soil after a rainstorm. In developed watersheds it flows off roofs and pavement into storm drains which may feed directly into streams; Stormwater carries pollutants from urban areas directly into local

waterways. By slowing, intercepting, and treating rainfall, trees can help reduce the volume of pollution-carrying stormwater runoff.

STRATUM STRATUM (Street Tree Resource Analysis Tool for Urban forest Managers) is a street tree management and analysis tool for urban forest managers that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits. Using an existing inventory of street trees, this software allows managers to evaluate current benefits, costs, and management needs.

Temporal Resolution Temporal Resolution represents the time frequency for the data. This component of data quality recognizes that it is not just the image quality that matters, but also when the information was acquired. The Chesapeake Bay Program Guidelines recommend that the data used in UTC assessment be less than five years old. In some communities, where rapid change or development is taking place, a much higher temporal resolution may be required (i.e. data that is less than one year old) to accurately reflect the extent of current tree canopy.

Three Ps When moving from a canopy assessment to an implementation plan, it is useful to separate the process into a sequence of steps. This allows the task to be broken into manageable components and prevents each step from being bogged-down by details that belong in later stages of the process. The Three Ps, Possible, Potential, and Preferable, provide a useful sequence for structuring the goal setting and implementation process. (See *Possible, Potential,* and *Preferable f*or more information).

Top-Down Top-down canopy assessments use remote sensing data, such as satellite imagery, to quantify the extent of tree cover. For most communities, a top down approach is recommended. This guide focuses on a top-down approach for several reasons. First, the Chesapeake Bay Program guidelines are based on tree cover and extent which are readily assessed using top-down methodologies. Second, percent cover is easy to conceptualize and communicate. Third, remote sensing makes it

easy to track progress over time. Lastly, these methods are well documented and have been used successfully here and elsewhere.

Urban Forests Urban forests include the trees in our yards, parks, public spaces, and along our streets. Though we don't often think of them as forests, they provide many forest benefits, such as cleaner air and water. In addition to environmental benefits, urban forests increase property values, reduce home energy costs, block UV radiation, buffer wind and noise, provide shade and beautify our neighborhoods.

Urban tree canopy (UTC) The layer of leaves, branches, and stems of trees that cover the ground when viewed from above.

Watershed This is the area that drains to a common waterway, such as a stream, lake, estuary, wetland, or the ocean. The Chesapeake Bay Watershed stretches across six states and includes all of the areas that eventually drain into the Bay

Glossary entries excerpted from : National Resource Stewardship. United States Forest Service. (2010, April 15). Urban Tree Canopy Assessment Glossary. Retrieved from http://www.nrs.fs.us/urban/utc/glossary