Urban Forests:

Opportunities for Urban Ecology

Introduction

Although we tend to appreciate trees for aesthetic reasons, the benefits of trees in an urban setting go far beyond beautification. Trees are essential for cleaning urban air, reducing building energy use, and protecting water quality and quantity. In urban environments, trees create healthier neighborhoods, provide necessary habitat for a variety of plants and wildlife and contribute to healthy local and regional ecosystems.

What is Urban Forestry?

An urban forest is the collection of all trees and vegetation in and around a town or city, "a collected greenscape that provides environmental, economic, and social benefits for today and into the future."[1]

> "The U.S. population has grown increasingly urban each decade, from 45 percent in 1910 to 80 percent in 2000."
> *-US Census Bureau, 2002*

Urban Forestry South (the urban and community forestry center for the US Forest Service's southeastern region) defines urban forestry as "the planning for and management of trees (individually and collectively) in urban settings or developed areas. Urban forestry advocates the role of trees as a critical component of the urban environment; i.e. green infrastructure."[3] Green infrastructure is an interconnected network of open spaces and natural areas that provides wildlife habitat, recreational opportunities and ecosystem services. Green infrastructure connections may be provided along streams, linear parks or along bike and pedestrian transportation corridors. This green infrastructure approach recognizes that urban and community forests function as a part of regional ecosystems, and can serve as vital links in a network.

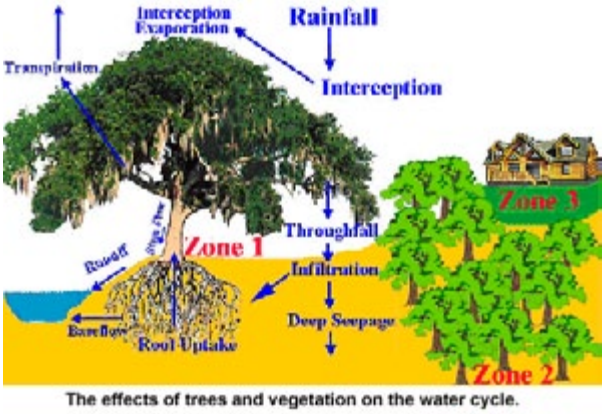
While all forests contribute to the regional ecosystem, the practice of forestry in an urban context differs greatly from the management of a large continuous forest area with a single owner or manager. Challenges of the urban environment include limited space, poor planting conditions, pollution and inadequate light and water. Urban forestry requires working with public and private landowners and across multiple jurisdictions and public agencies. Given these pressures, urban forestry seeks to maintain and increase tree canopy cover and preserve trees in areas under development.

"*Urban Forestry* has brought attention to trees as air pollution remedies since trees and other plants directly absorb carbon in their life-dependent process, photosynthesis. By taking in carbon dioxide trees naturally remove excess carbon and other chemicals, such as nitrogen oxides, airborne ammonia, some sulfur dioxide, and ozone, that are part of the smog and greenhouse effect problems."[2]

Mature Red Maples can absorb over 3,000 gallons of stormwater annually.

How are Trees Valuable to the Urban Ecosystem?

Trees are major assets for urban ecological health, valued for their utility and the array of ecosystem services they provide for humans and wildlife alike.[4] Ecosystem services is the term given collectively to all resource and process benefits derived from natural ecosystems. Preserving a municipality's city-wide tree canopy including private and public forests and wildlife or open space corridors enables better urban ecosystem services such as erosion control, water quality and supply, and even air quality. For ages these benefits were considered limitless, but the more scientists and the public learn of



The effects of trees and vegetation on the water cycle.

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the limitations of these services, the greater their value becomes. The economic value assigned to ecosystem services approximates how much it would cost to replicate these services with artificial alternatives.

One example of ecosystem services from urban trees is the mitigation of air pollution. Urban trees not only produce oxygen through photosynthesis, but also filter out harmful pollutants such as ozone, carbon monoxide, sulfur dioxide and particulates emitted from automobiles and industrial processes, improving urban air quality.

Urban forests can also help mitigate the effects of urban stormwater and improve groundwater recharge and water quality. Rainwater falling on urban areas strikes largely impermeable surfaces, where it accumulates pollutants and trash before running off into stream channels at high velocities. The rush of water entering stream channels causes erosion and stream bank collapse, and stormwater has no chance to infiltrate the soil and recharge crucial groundwater supplies. Trees slow stormwater flows through uptake and storage of water in leaves and bark; their roots also create pathways through which water can infiltrate the soil. Slower flows mean more chances for natural filtering of pollutants and for groundwater recharge. During major flood events, root systems can also help stabilize and protect stream banks from erosion.

"Trees improve infiltration capacity and stormwater runoff in urban areas."

-Dudley Hartel, USDA Forest Service

The Value of Trees in an Urban Setting:

- "Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20 - 50 percent in energy used for heating."
  -USDA Forest Service
- "Trees can be a stimulus to economic development, attracting new business and tourism. Commercial retail areas are more attractive to shoppers, apartments rent more quickly, tenants stay longer, and space in a wooded setting is more valuable to sell or rent."
  -The National Arbor Day Foundation
- "Shade from trees could save up to $175 per year (per structure) in air conditioning costs."
  -Dr. Lowell Ponte
- "The net cooling effect of a young healthy tree is equivalent to ten room-size air conditioners operating 20 hours a day."
  -U.S. Department of Agriculture
- "One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people."
  -U.S. Department of Agriculture
- "In laboratory research, visual exposure to settings with trees has produced significant recovery from stress within five minutes, as indicated by changes in blood pressure and muscle tension."
  -Dr. Roger S. Ulrich Texas A&M University
- "Nationally, the 60 million street trees have an average value of $525 per tree."
  -ICMA / Management Info. Services

Trees are also valuable for their cooling abilities. On warm summer days, temperatures in urban areas may be 6-8°F hotter than in surrounding rural areas.[5] This temperature increase, brought about by high levels of impermeable and darker, reflective surfaces found in cities, is termed the "urban heat island". Shade trees, when strategically planted, can reduce cooling loads by as much as 25% to help relieve the effects of the urban heat island.[6] A recently published study out of Auburn University found that increasing heavy shade around a home decreased both power usage and costs by 11.4%, over a similar situation without shade. The researchers equated this to an average of $32 in savings per month. Dense foliage and late afternoon shade were found to be particularly important in reducing energy costs.

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Threats to the Urban Forest

One of the challenges of urban forestry is how to support tree health to maximize these ecological services. The greater the tree canopy and the smaller the impervious areas found in a given district, the better the ecological services. In order to thrive, trees must have ample space for leaves and roots to grow, the right microclimate (such as sufficient warmth or light), and be provided with the proper soil, water, and protection from urban activities like overhead power lines, underground utilities, and automotive or industrial pollutants. Many tree species require ample soil volume to thrive, which is not always realistic in urban areas. While an area free of pavement intrusions helps root growth and tree health, planning and appropriate selection are more critical to long term success of the urban forest.

The ecological functions of trees depend largely on their location and the degree to which urban growth affects tree canopy. In Virginia, the average tree canopy coverage for urbanized areas is 35%. This average translates into 767,000 urbanized acres of the Commonwealth's land area that are covered with tree canopy. These trees are estimated to absorb millions of pounds of air pollutants each year. As Virginia's urban centers grow, urban forests are fragmented by lot clearing and road construction and increasingly disconnected from regional forest ecosystems, impairing the forests' chances for survival and ability to provide services we value.

For example, Fairfax County's tree canopy, which covers around 104,000 acres (41%) of that jurisdiction's area, is estimated to intercept and absorb 5.5 million pounds of gaseous and particulate air pollution per year.7 Since the early 1970s, Fairfax County has seen a 48% decline in tree canopy, an area equivalent to 85,6000 acres. Lost tree canopy had the capacity to remove approximately 2.4 million combined pounds of sulfur dioxide, carbon monoxide, ozone, and particulate matter (10 microns or less) annually, at a value of approximately $6.8 million per year. In Fairfax County, loss of tree canopy is a contributing factor to the significant decreases in water quality, energy conservation and other socio-economic and environmental benefits associated with urban forests.[8]

Useful resources to consult before starting an urban forestry program include:

- Virginia Cooperative Extension
- certified or consulting arborists, and
- community or urban foresters familiar with your area.

With over 800,000 acres of land anticipated to be developed in the Chesapeake Bay Watershed between 2003 and 2030, primarily for residential use, healthy urban forests that serve as connections in an increasingly fragmented regional forest ecosystem will become increasingly crucial. Virginia localities will need to take conscious steps to support tree health by implementing tools and policies that avoid soil compaction, maintain a diversity of forest habitat, and promote low impact development techniques for urban storm water retention and flood prevention.[9]

Tools to Protect the Urban Forest

Fortunately, there are a number of planning tools available to reduce impacts of development on urban forests. Examples of such tools include conservation zoning ordinances to preserve the upper tree canopy along riparian zones, and incentives that reward developers for preserving sensitive habitat and trees over a certain diameter. Also, requiring the planting of native trees in development projects along urban and neighborhood streets can be an effective way to add value to the urban streetscape while supporting urban ecology.

Tree Canopy Goals:

Baltimore, MD: to obtain 39.6% canopy over 30 years

Annapolis MD: to obtain 50% canopy over 30 years

Leesburg, VA: to obtain 40% canopy over 40 years

Arlington County: to obtain 40% canopy

Fairfax County: to obtain 45% canopy over 30 years

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Current Virginia State Code limits the amount of tree canopy preservation that localities can mandate within "by right" development. This limit poses a challenge to localities in maintaining their tree canopy, especially in areas experiencing rapid development. Current state code (Section 15.2-961) empowers local authorities to establish percentages for tree cover replacement in new development, but does not authorize regulations that specifically require tree preservation or limit tree removal. Local ordinances cannot require more than 20% tree cover replacement. Efforts by local governments since 2003 to amend Virginia's tree preservation legislation have been unsuccessful. The Virginia building and timber industries argue that a requirement for tree preservation would be too burdensome and costly, and have lobbied heavily to protect their interests11. In 2008, Virginia House Bill 1437 proposed amending 15.2-961 to allow jurisdictions with air pollution problems to focus their tree ordinance on tree protection rather than tree replacement.

In Virginia, Arlington, Roanoke, and Leesburg have already implemented tree preservation strategies that aim to protect and conserve their urban forests.

In October 2008 Fairfax County adopted a new tree preservation ordinance. The purpose of the ordinance is to "provide for the conservation of trees during the land development process…to protect, sustain, and enhance the County's urban forest resources". The ordinance set up 10, 20, and 30 year tree canopy requirements. Tree Conservation Plans are required as a part of subdivision plats to address the canopy requirements. Developments meet these requirements first through tree preservation, with tree planting as a secondary option[10].

Tree Canopy Loss Projections:
(From Fairfax County Tree Action Plan)

- Even with current levels of tree protection, the tree canopy will decrease in size from 41% to around 37% over the next 30 years
- The projected loss is 10,200 acres of tree canopy over the next 30 years

Urban Forest Tools in Action: Urban Tree Canopy Assessments, i-Tree Eco analysis

Urban Tree Canopy Assessments
These assessments provide the community with data about their canopy cover and percentage in relation to buildings/roads, water, and other vegetated land cover. Communities can utilize the assessment to help identify areas that may need additional tree cover and to develop an implementation plan for increasing canopy.

Urban tree canopy is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Urban tree canopy provides many benefits to communities including improving water quality, conserving energy, lowering city temperatures, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits.

Urban Tree Canopy assessments have been done for 27 communities in Virginia from Winchester to Abingdon to Virginia Beach and Arlington County. High resolution images are analyzed to determine how much of the city is currently covered by tree canopy. The land cover is divided into percentages of water, impervious, impervious building, other vegetation and tree canopy. The data can be used as a basis for setting an urban tree canopy goal, either for the entire city or for sections of the community where tree canopy is below the desired percentage.

Once the goal has been set an implementation plan can be developed. The plan will usually cover 10-30 years as trees take time to grow. The plan should include the process for evaluating progress in attaining the goal.

There are a few challenges associated with canopy goals. First is the cost of obtaining high-quality imagery. Second is the cost of hiring specialists to analyze the imagery. Third is that most of the opportunities for increasing canopy cover exists on private property. And finally, it is difficult to ascertain the difference between high and low quality tree canopy. For example, the widespread tree cover in a park may be filled with invasive ailanthus or privet or native Virginia pine that is 45 years old which

is at the end of its natural cycle. It is imperative that any community considering an urban tree canopy goal understand these challenges and limitations.

i-Tree Eco

Trees provide a long list of ecologic and economic benefits that improve environmental conditions and human well-being. Trees in urban settings are especially important. To better understand an urban forest's structure, function, and value, i-Tree Eco (formerly the Urban Forest Effects (UFORE) model) was developed to help promote management decisions that will improve human health and environmental quality.

i-Tree Eco is designed to use standardized field data from randomly located plots and local hourly air pollution and meteorological data to quantify urban forest structure (e.g., species composition, tree health, leaf area, etc.) and its numerous effects, including:

- Amount of pollution removed hourly by the urban forest, and its associated percent air quality improvement throughout a year. Pollution removal is calculated for ozone (O3), sulfur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), and particulate matter <10 microns (PM10).
- Total carbon stored and net carbon annually sequestered by the urban forest.
- Effects of trees on building energy use and consequent effects on carbon dioxide emissions from power plants.
- Structural value of the forest as well as the value for air pollution removal and carbon storage and sequestration.
- Potential impact of infestations by Asian longhorned beetle, emerald ash borer, gypsy moth, and Dutch elm disease

End Notes:

1. City of San Francisco Urban Forestry Council, http://sfgov.org/site/sfenvironment_page.asp?-id=24659

2. McPherson , E. Gregory. et. al. *Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting,* 2005 (http://urbanforestrysouth.org/resources)

3. Urban Forestry South, USDA http://www.urbanforestrysouth.org/Resources/FAQs/FAQ.2004-03-17.4549/view

4. http://www.urbanforestrysouth.org/Resources/FAQs/FAQ.2004-03-17.4549/view

5. Urban Heat Island Group, http://eetd.lbl.gov/HeatIsland/LEARN/

6. US EPA, http://www.epa.gov/hiri/strategies/index.html

7. Urban Ecosystem Analysis of Fairfax County, Virginia: Calculating Forest Cover Loss and Related Values in Fairfax County. American Forests, 1999

8. Kirwan, Jeff, and Kane, Brian. "Urban Forestry Issues" Publication Number 420-180, Posted July 2005

9. Issue Brief: Tree Cover Preservation and Replacement Regulations, http://www.fairfaxcounty-watersheds.net/uploads/documents/6/MP_treecover_regs_06_28_05_.pdf

10. Fairfax County Tree Ordinance, http://www.fairfaxcounty.gov/dpwes/publications/pfm/treeconservation/

11. http://americanforests.org/resources/urbanforests/greeninf.php

12. Shade Trees Can Reduce Power Bills by 11.4 Percent. Nov 14, 2008. http://yubanet.com/life/Shade-Trees-Can-Reduce-Power-Bills-by-11-4-Percent.php

Image Sources:

PAGE 1- (Red Maple in fall color)http://www.maes.umn.edu/releases/images/2864-V-079.jpg&imgrefurl=http://www.maes.umn.edu/releases/ornatrees.asp&h=552&w=559&sz=291&hl=en&start=32&tbnid=r_lnsgNEkVZZWM:&tbnh=131&tbnw=133&prev=/images%3Fq%3Dred%2Bmaple%2Bfall%2Bcolor%26start%3D20%26ndsp%3D20%26svnum%3D10%26hl%3Den%26lr%3D%26client%3Dsafari%26rls%3Den%26sa%3DN

PAGE 2- (Top left) see end note #2; tree physiology: http://www.treelink.org/images/watercycle.gif (Bottom left) City of Coral Gables, Coral Way, http://community.iexplore.com/photogallery/displayFeaturePhoto.asp%3FID%3D85035&h=336&w=448&sz=52&hl=en&start=4&tbnid=h8_rUKlexbMDcM:&tbnh=95&tbnw=127&prev=/images%3Fq%3DCoral%2BGables%2BCoral%2BWay%26svnum%3D10%26hl%3Den%26lr%3D%26cl ient%3Dsafari%26rls%3Den%26sa%3DG; p. 3 -(Eagan, MN City Green images)http://rsl.gis.umn.edu/citygreen_classification.html; pollutant removal for the 3 States.

PAGE 3 - (City Green in Quarry Park, Charlottesville) "Study of Envtl Sustainability: Options for City Parks and School Lands" report by UVA grad students for the City of Charlottesville, Nov. 2006.

Resources:

Green Infrastructure Valuation Tool-quick and easy evaluation:
http://greenvalues.cnt.org/

American Forests Organization:
http://www.americanforests.org/

The Benefits of Urban Trees: A Literature Summary. Warwick District Council, UK. 2003. http://www.cfr.washington.edu/research.envmind/ UF/TreeBenefitsUK.pdf

Tools and inspiration to improve urban and community forests:
http://www.treelink.org/

Issue Brief-Tree Cover Preservation and Replacement Regulations:
http://www.fairfaxcounty-watersheds.net/uploaments/6/MP_treecover_regs_06_28_05_.pdf

The Historic Tree Nursery:
http://www.historictrees.org/

National Alliance for Community Trees
http://www.actrees.org/

National Arbor Day Foundation
http://www.arborday.org/index.html

Urban Forestry Database:
http://forestry.lib.umn.edu/bib/urban.phtml

Urban Forests and Human Benefits, Human Dimensions of Urban Forestry and Urban Greening
University of Washington: College of Forest Resources:
http://www.cfr.washington.edu/research.envmind/
http://www.cfr.washington.edu/research.envmind/urban.html

Virginia Department of Forestry: http://www.dof.virginia.gov/

Virginia Department of Forestry, Urban and Community Forestry: http://www.dof.virginia.gov/urban/index.shtml

Virginia Urban Forest Council : http://www.treesvirginia.org/