

Urban Forestry in North America

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Introduction

Urban forestry is the planning and management of trees, forests, and related vegetation within communities to create or add value. Urban forests add value to local communities because they are integral to land-use planning, mitigating water and energy shortages, improving air quality, protecting global climate, enhancing public health programs, increasing land values and local tax bases, providing job training and employment opportunities, reducing costs of city services, and increasing public safety.

During the past decade, the urban and community forestry paradigm has shifted from focus on beautification to one that encompasses all of the environmental, conservation, economic, and social benefits of community trees. This shift has been accompanied by increasing local participation and new partnerships that link professionals, non-governmental organizations, industry, and government agencies. Increased investment will follow as new markets emerge for the ecosystem services that urban forests produce.

Issues Associated with Urbanization

North America's (Canada, Mexico,

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and the United States) urban population is 348 million or 80% of its total population. The number of people residing in urban areas is expected to increase to 439 million or 85% in 2025 (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2006).

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Although the pace of urban growth will slow in North America as a whole, rapid urban growth will continue in the poorest regions and those undergoing the greatest economic change. In other areas, populations are expected to shift away from vast sprawling metropolitan regions to small or intermediate-sized cities. The benefits of urbanization include higher incomes and literacy rates, as well as increased health. However, with urbanization has come a host of environmental and social

problems. Some of these problems are associated with urban poverty (e.g., insufficient sanitation, disease, lack of access to clean water, food, and fuel supplies) and others with economic growth or affluence (e.g., air and water pollution, congestion, loss of biodiversity). The problems of pollution, poverty, and environmental hazards facing North American cities are similar to, but less extreme than, those faced by much of the world's population in cities in developing countries.

The Role of Urban Forestry

Urban forests are important because of their geographic extent, their impact on local economies, and their proximity to people. Collectively, urban trees in the contiguous U.S. account for nearly one-quarter of the nation's total tree canopy cover—some 74.4 billion trees (Dwyer et al., 2000). The annual total impact of urban forestry related sales in California was \$3.8 billion, while the state's commercial forest-products industry had sales of \$12.5 billion (Templeton and Goldman, 1996). Because of their proximity to people, urban forests can provide substantial environmental, social, economic and recreational benefits to urban dwellers.

Air Quality and Climate Protection: Although urban air quality has improved over the past two decades in most North American cities, worldwide more than 1 billion people live in urban areas with unhealthy air. Rising motor vehicle use, reflecting the in-

creasingly sprawling form of many cities, poses the greatest threat to air quality. Urban centers, where energy consumption is high, are important sources of greenhouse gases that pose a threat to the stability of global climate. Urban forests have a positive impact on air quality through adsorption of pollutants to the vegetation canopy, sequestration of atmospheric carbon dioxide in woody biomass, reduction of summertime air temperatures and associated ozone formation, and energy savings that reduce power plant emissions. For example, California's 177 million urban trees are estimated to save 6,400 GWh in annual electricity use for air conditioning, equivalent to seven 100 MW power plants (McPherson and Simpson, 2003).

Urban Poverty: Urban poverty is a serious problem in the largest North American cities because the poorest groups face the greatest exposure to biophysical threats (e.g., inadequate water, housing, sanitation), biological hazards (e.g., infectious and parasitic diseases), and social ills (e.g., violence, substance abuse, unemployment) and have the least access to protective services.

Greenspace resources are often inadequate in areas where they are needed most. For example, in low-income areas and areas of concentrated poverty in Los Angeles, as well as in neighborhoods of predominantly Latinos, African Americans, and Asian-Pacific Islanders, residents have dramatically lower levels of access to park resources than areas dominated by white residents (Wolch et al., 2005). In some cities, urban gardening can contribute significantly to the food supply (Kuchelmeister, 1998).

Water Resources: Cities produce wastewater that requires treatment and polluted runoff that threatens human health, as well as the functioning of freshwater and coastal ecosystems. Although water is not scarce in North America, many large cities face water

shortages. For example, rapid growth and dependence on groundwater has led to aquifer depletion, ground subsidence, and implementation of water conservation measures in Mexico City, Houston, and Tucson. By reducing runoff from small storms, which are responsible for most annual pollutant washoff, trees protect water quality. Some cities own peri-urban forests that provide municipal drinking water, and others, such as New York City, have invested in conservation easements to protect watersheds instead of investing in new treatment facilities. Seattle owns a large tract of urban forest that it uses for land treatment of sewage wastes.

Solid Waste: Approximately 20% of the urban solid waste stream is yard (organic material from lawns, shrubs, and trees) and wood waste. Recycling of this green waste can reduce the environmental and economic costs associated with landfill disposal. Returning green waste to the soil can benefit plant growth and conserve water. Portable mills are being used in pilot programs to salvage lumber that is used for products such as picnic tables, park benches, flooring, and veneer.

Mental Health and Well-Being: City life is stressful. Visiting green areas in cities can counteract stress, renew vital energy, and speed healing processes. A study of relationships between greenspace and human health found that people living in a greener environment show more signs of healthy living (de Vries et al., 2003). The urban forest is where most people experience and learn about forests. Involvement in tree planting, management, and restoration of urban forests is, in itself, an important form of outdoor recreation with significant individual and community benefits.

Economic Prosperity: In disadvantaged neighborhoods, tree planting and stewardship jobs are providing economic opportunities for local youth. Large-scale tree planting initiatives,

like those sponsored by mayors in Chicago, Los Angeles, Denver, Seattle, and Albuquerque, are building "green-collar" economies and invigorating neighborhoods. Research has found that shoppers spend more money and shop longer in commercial areas with many trees than in those with few trees (Wolf, 2005).

Loss of Biodiversity: Urban areas affect biodiversity through conversion of land to urban uses. Many cities are rapidly expanding outward, reducing and fragmenting habitat. Greenways, riparian buffers, and parks systems can provide continuous corridors that give wildlife cover, food, and paths for travel. Expanding urban forests can constrain alien plant (e.g., Norway maple [*Acer platanoides*] and buckthorn [*Rhamnus* spp.]) and insect species (e.g., emerald ash borer [*Agilus planipennis*]) that threaten native forest flora.

Constraints to Urban Forestry

Although there is potential for urban forests to mitigate a variety of impacts associated with development, there are also a number of obstacles to overcome before significant urban forest benefits can be realized. Resolving these limitations will require coordinated efforts among cities, regions, and countries (Meza, 1992; Nilsson et al., 2000).

- Available growing space is limited in city centers, and this problem is compounded by pressure to convert greenspace, parks, and vacant lots into building sites (Glickman, 1999). In suburban areas, sprawling development seldom includes enough park space or makes provisions for the funds required to maintain them.

- Municipal tree care programs are inadequately funded, and the resources needed to respond to natural catastrophes (e.g., ice storms, hurricanes), conduct urban forest inventories, develop management plans, enforce ordi-

nances, and monitor tree health are lacking.

- Parks and natural spaces are over-used.
- Harsh growing conditions, such as soil compaction and drought, make tree survival an achievement.
- Information about the tolerances of tree cultivars to urban environmental constraints such as de-icing salts is lacking.
- Poor tree selection exacerbates maintenance problems.
- Much nursery stock is poor, and adequate care after planting is not provided.
- Many municipal urban forests are dominated by relatively few species, and genetic diversity is limited.
- Tree care practices by citizens and untrained arborists are inadequate.
- Too few communities have working tree inventories, and very few have urban forest management plans.
- Adoption and enforcement of ordinances that regulate street tree removal and types of species planted, protect trees during construction, preserve heritage trees, and require planting with new development are lacking.
- Outreach to professionals and residents is limited.
- Grass-roots participation in tree planting and stewardship is limited.
- Public awareness about the benefits of healthy urban forests is lacking.
- Jurisdictional complexity frequently results in agencies working at cross-purposes or duplicating each other's efforts.

Regional Urban Forest Plans

Leadership and vision that soars above jurisdictional boundaries is needed to realize the many environmental, social, and economic benefits that urban forests can provide. Implementation of regional urban forest plans can foster multifunctional regional greenspace systems with connecting corridors and easy access.

More efficient delivery of tree care services can result from greater collaboration among agencies. Multiple sets of policies, ordinances, standards, and specifications can be merged; and coordinated regional urban forest inventory, maintenance, and health monitoring programs can be implemented.

This vision is becoming a reality in the Sacramento region through a program called Greenprint. Greenprint was launched by the Sacramento Tree Foundation (STF) when regional planners released their initial Blueprint for the region's future growth and development. STF recognized that tackling the problems in a region whose population is expected to double to over 3 million by 2050 required regional solutions. To ensure a green future they adopted the goal of doubling the region's tree canopy cover by 2045 (STF, 2005). The end result will be 35% average canopy cover in urban areas, and tree benefits in excess of \$100 million per year. As a result of a public involvement campaign, 26 of 28 cities and counties in the Sacramento Area Council of Government's (SACOG) jurisdiction have now signed on to the Greenprint.

To maximize urban forest benefits, STF has compiled technical advice from planners, engineers, arborists, landscape architects, and policy makers into a formal document, "Guiding Principles and Best Strategies." Using the Forest Service's new i-Tree software, and with the help of a team of volunteers collecting data, STF is quantifying the annual benefits and costs of the region's trees and identifying the most important tree management needs.

Improving the region's air quality through large-scale tree planting will be an important driver of the Greenprint. SACOG and the Sacramento Metropolitan Air Quality Management District have awarded STF a \$725,000 grant to study how investment in urban forest expansion will pay the big-

gest dividends in terms of air quality (STF 2006). Scientific data will be used to develop a tree planting and replacement program that will be submitted as part of the State Implementation Plan (SIP). New guidance from U.S. Environmental Protection Agency (EPA) allows measures such as strategic tree planting to be included in SIPs as a means to help meet air quality standards. A preliminary evaluation found that planting six million trees to increase tree canopy cover by five percent will reduce ozone, nitrous oxides and volatile organic compounds by 3.4, 0.7, and 7.6 tons per day in 2023 (Simpson and McPherson, 2006). The annual combined reduction of 1,710 tons is highly cost-effective.

One Forest and Watershed Restoration

The growing disconnection between urban residents and natural resources poses a problem for agencies that manage lands outside cities. To remain relevant, agencies must strive to make every city dweller a stakeholder. One way to make an emotional and intellectual connection with an increasingly diverse population is through participation in urban greening activities. Transforming human habitats into greener and more livable environments will create a cadre of stakeholders who understand the value of investment in natural resource management, both inside and outside cities. Our challenge is to foster this stakeholder connection and prevent conceptual boundaries between rural and urban forestry from impeding the process.

The concept of One Forest provides a framework for linking ecosystem services and human values along the urban-to-rural gradient. One Forest emphasizes the continuity of our forests, landscapes and other ecosystems across all lands, from inner city forests to the most remote parts of our national forests and wilderness areas. The connec-

tion is demonstrated through associations within, and across, individual watersheds and expressed in the relationship each ecosystem has, whether rural or urban, to water, climate, invasive species, soils, wildlife, people, and the natural cycle of fire. Watersheds along an urban-to-rural gradient provide a definable organizing structure for understanding a region's ecosystem. One Forest provides a framework for answering the question: "How does the quality of water, air, soil, vegetation, and wildlife habitat change as one travels from the headwaters of rivers to their confluence with downstream water bodies?" Answering this question requires understanding the individual and cumulative effects of urbanization and land management practices on land, air, water, and biological resources (e.g., watershed health) along the urban-to-rural gradient. Corollary questions are: "What are the Best Management Practices for sustaining healthy watersheds in urban, suburban, and rural lands?" and "How can international and national resources best facilitate local efforts to create landscapes for sustainable living?"

The One Forest concept is being implemented in the Chesapeake Bay region, where restoring water quality is a shared regional goal. In Baltimore's highly urbanized, low-income Watershed 263, a host of partners are exploring new approaches to stormwater management (Richardson, 2006). Every stream in the watershed has been buried. A community stakeholder council is implementing watershed restoration projects in partnership with the Baltimore Department of Public Works, the nonprofit organization Parks & People, the Center for Watershed Protection, and the U.S. Forest Service. For example, the Schoolyard Greening Initiative is replacing asphalt school yards with ball fields, rain gardens, butterfly gardens and tree groves designed as reading areas.

In other parts of the watershed, re-

search is evaluating how bioretention basins, small wetlands, and specially designed drainage inlets influence stormwater quality. The long-term effects of 107 individual projects dispersed across the watershed will be tracked using quality-of-life indicators, such as tree canopy expansion. With over 55 agencies and organizations contributing to the restoration effort, Watershed 263's ripple is being felt throughout the region.

That ripple has potential to become a current of change for 16 million people living in the Chesapeake Bay watershed. Watershed restoration efforts are now targeted at conserving forests, reducing phosphorus in home lawn-care products and supporting efforts to fund Bay-friendly farming practices. Recognizing the importance of healthy urban forests, the Chesapeake Bay Program is working with five communities to assess their canopy cover, adopt increased canopy goals, and implement tree planting and conservation programs. Guidelines for implementing tree canopy goals have been piloted in Montgomery County, MD and Baltimore (Geotz et al., 2003; Galvin et al., 2006). The integration of urban forestry and watershed management in the Chesapeake Bay region is becoming a model for other North American cities.

Closing

Our concept of nature in cities must change as, for example, our concept of a zoo has evolved. Over the past fifty years the design of zoos has changed. Zoos are no longer a series of identical, sterile concrete cages with metal bars. Rather, zoos now contain widely different habitats, each carefully designed to mimic the native environment of the animal it houses. Unlike the old zoos, these wild animal parks have been designed to nurture the spirit and health of their inhabitants.

Like these "zoos of the future," we

are realizing the value of designing cities with healthy and diverse urban forests to nurture our souls and protect our health. With urbanization there will be more opportunities to incorporate urban forests into the fabric of North American cities. Investing in urban greening is one of the most important things we can do for the future of natural resource conservation. If a new conservation ethic is to emerge, it will come forth from our cities as the product of encounters with nature where people live. Why would we want our cities of the future to resemble our zoos of the past?

References

- De Vries, S., Verheij, R.A., Groenewegen, P.P., and Spreeuwenberg, P. 2003. Natural Environments—Healthy Environments? An exploratory analysis of the relationship between green-space and health. *Environment and Planning*. 35: 1717-1731.
- Dwyer, J.F., Nowak, D.J., Noble, M.H. and Sisinni, S.M. 2000. Connecting People with Ecosystems in the 21st Century, an Assessment of Our Nation's Urban Forests. Gen. Tech. Rep. PNW-GTR-490. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 483 p.
- Galvin, M.F., Grove, J.M., and O'Neil-Dunne, J. 2006. A Report on Baltimore City's Present and Potential Urban Tree Canopy. Maryland Department of Natural Resources, Annapolis, MD. 17 pp.
- Geotz, S.J., Wright, R.K., Smith, A.J., Zinecker, E. and Schaub, E. 2003; IKONOS imagery for resource management: Tree cover, impervious surfaces, and riparian buffer analyses in the Mid-Atlantic region. *Remote Sensing of Environment*, 88(203): 195-208.
- Glickman, D. 1999. Keynote Address. In: C. Kollin (Editor), Building

- Cities of Green: 1999 National Urban Forest Conference. *American Forests*, Washington, DC. pp. 4-7.
- Kuchelmeister, G. 1998. Urban Forestry in the Asia-Pacific Region—Status and Prospects, Asia-Pacific Forestry Sector Outlook Study, Working Paper No: APFSOS/SP/44. Forestry Policy and Planning Division, Rome, Italy.
- McPherson, E.G., and Simpson, J.R. 2003. Potential energy savings in buildings by an urban tree planting program in California. *Urban Forestry & Urban Greening*. 2:73-86.
- Meza, H.M.B. 1992. Current situation of the urban forest in Mexico City. *J. Arbor.*, 18: 33-36.
- Nilsson, K., Randrup, T.B., and Wandall, B.I.M. 2000. Trees in the Urban Environment. In: J. Evans (Editor), *The Forest Handbook*. Blackwell Science, Oxford.
- Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. 2006. World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision. Accessed via the World Wide Web, <http://esa.un.org/unpp>, September 28, 2006.
- Richardson, D.C. 2006. Watershed 263: A Resource Uncovered. *Stormwater*. 7(6): 54-65.
- Sacramento Tree Foundation. 2005. Greenprint: A Regional Urban Forest Initiative. Sacramento Tree Foundation. Sacramento, CA. 15 pp.
- Sacramento Tree Foundation. 2006. Accessed via the World Wide Web, <http://www.sactree.com/aboutUs/programsServices/greenprint/greenprintOverview.html> on September 28, 2006.
- Simpson, J.R., and McPherson, E.G. 2006. Air Quality Effects of a Regional Tree Planting Program for Use in an Urban Forestry-Based SIP Measure. Internal Technical Report. Davis, CA: Center for Urban Forest Research, USDA Forest Service, Pacific Southwest Research Station.
- Templeton, S.R. and Goldman, G. 1996. Urban forestry adds \$3.8 billion in sales to California economy. *California Agriculture*, 50(1): 6-10.
- Wolch, J., Wilson, J.P., and Fehrenbach, J. 2005. Parks and park funding in Los Angeles: An equity mapping analysis. *Urban Geography*. 26:4-35.
- Wolf, K.L. 2005. Business district streetscapes, trees, and consumer response. *Journal of Forestry*. 103(8): 396-400.