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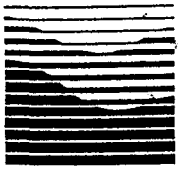

American Society of Landscape Architects
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2. VALUE OF LANDSCAPE ARCHITECTURE TO SOCIETY

URBAN FOREST LANDSCAPES, HOW GREEENERY SAVES GREEENBACKS

E. Gregory McPherson, Ph.D.

They are small pockets of green in an otherwise concrete landscape. They are islands of life and beauty tucked between suburban development and busy streets. They are small enclaves of serenity in a bustling world of business and traffic. They are our urban forest landscapes.

Each day about 990 hectares (2,450 ac) of open land is developed. By the year 2000 approximately 80% of the country's population will live in urban forest landscapes. As communities compete to attract new business, create jobs, and maintain vigorous local economies, quantifying impacts of development on the environment is becoming increasingly important. Most citizens want a high level of environmental quality and a growing economy. Landscape architects and their clients need to know the extent to which investment in public and private landscapes can effectively mitigate the environmental impacts of economic development and contribute to improved quality of life. As cities grow it becomes increasingly important to understand the structure, function, and value of ecosystems that can thrive in our rapidly urbanizing landscapes.

Increasingly, in a "do more with less" world, landscape architects must evaluate tradeoffs and conflicts between landscape structures with different purposes, and design landscapes that control maintenance costs while producing multiple benefits. Typical examples of costs include tree root damage to sidewalks, landscape water use, production of green waste, pesticide and herbicide use, and emission of biogenic hydrocarbons that can contribute to ozone formation.

At the same time, it is important to understand and to include the benefits of the urban forest in landscape planning. A number of studies have established relationships between different urban forest structures and specific benefits such as visual quality, energy savings, removal of atmospheric carbon dioxide, wildlife habitat, and personal safety. However, quantitative techniques for evaluating tradeoffs associated with multiple functions from a specific landscape are lacking. This paper highlights initial results of Forest Service research that quantifies the contributions of urban forest landscapes to quality of life. Information such as this can be used to document the value of the landscape architecture profession to society.

Sacramento Urban Forest Ecosystem Study

The primary purpose of the Sacramento Urban Forest Ecosystem Study (SUFES) is to enhance our understanding of the region's urban forest ecosystem by quantifying its structure, function, and value. Findings are being used by policy makers, resource managers, and the Sacramento Urban Forest Task Force to develop a shared vision for stewarding a sustainable urban forest.

Methods. The study area is Sacramento County (2,578 km2, 995 mi2) and contains 1.13 million people. Sacramento County is subdivided into 71 SubRADs (Sub-Regional Assessment Districts), with SubRAD boundaries following census block group boundaries. To depict variation along an urban-rural gradient (a theoretical transect extending from city center to exurban areas) the study area was subdivided into three sectors: 1) the City Sector (approximately congruent with City of Sacramento limits), 2) Suburban Sector, SubRADs outside the city with an average population density of 7.4 persons per ha (3/ac), and 3) Rural Sector, SubRADs outside the city with an average population density of less than 7.4 persons per ha (3/ac). Data regarding urban forest structure (e.g., tree canopy cover, numbers, species, size, health) were collected from aerial photographs

and 675 randomly located 100 m2 plots. More intensive surveys of existing and potential tree planting sites were conducted at 133 homes, where questionnaires were left with residents to understand attitudes about trees and their tree care practices. Eighty of the questionnaires were returned. A number of simulation models were used to estimate the amount of atmospheric carbon dioxide removal, air pollution deposition, and air conditioning savings attributed to the existing urban forest.

Initial Findings. SUFES data are being analyzed. Preliminary results indicate that there are approximately 6 million trees in Sacramento County: 1.7 million in the City Sector, 2.4 million in the Suburban Sector, and 1.9 million in the Rural Sector. On average, there are about 6 trees per resident throughout the County. Tree density decreases along an urban-to-rural gradient: average of 73 trees/ha in the City Sector, 64 trees/ha in the Suburban Sector, and 10 trees/ha in the Rural Sector. Low density residential areas have the highest tree densities (33-138 trees/ha) and transportation areas have the lowest densities (0-6 trees/ha). About 70% of trees in the County are in excellent or good condition and only 10% are in poor, dead, or dying condition. Generally, tree condition declines along the urban-to-rural gradient, with relatively more poor, dead, or dying trees in the Rural Sector where fewer trees are intensively managed. Species are distributed most evenly in the City, least evenly in Rural Sectors. The top ten species account for 37%, 45%, and 82% of City, Urban, and Rural Sector population totals, respectively. In the City Sector, smaller "under story" trees are most common (Juniperus spp., Betula spp.,Camellia japonica, Cornus spp.), along with elms (Ulmus spp.), palms (e.g., Phoenix spp., Washingtonia spp.), and redwoods (Sequoia sempervirens). In the Urban Sector, native oaks (Quercus wislizenii and lobata), shade trees (Morus spp., Celtis spp., Liquidamber styraciflua), redwood (Sequoia sempervirens), Italian cypress (Cupressus sempervirens Stricta'), and flowering cherry (Prunus spp.) are abundant. In the Rural Sector, native trees such as oaks (Quercus kelloggii, douglasii, wislizenii, and lobata) and foothill pine (Pinus sabiniana) are mixed with hardy exotics such as silk tree (Albizia julibrissan), Russian olive (Elaeagnus angustifolia), and sweetgum (Liquidamber styraciflua). Aesthetics and tree shade are reported to be the two top reasons people plant trees.

To estimate the dollar value of annual benefits the urban forest produces during one year the Council of Tree and Landscape Appraisers methodology was used to calculate the replacement value of the region's existing trees (McPherson et al 1994; McPherson 1995). By "growing" the forest one year and recalculating its replacement value (assuming no change in tree numbers, conditions, or locations), the value-added due to tree growth was found to be approximately $544 million, or $90 per tree on average (Table 1). Based on results from our initial simulations, the region's urban forest is estimated to provide annual benefits valued at $25 million for air conditioning savings (234 GWh), $36 million for air pollutant uptake (1,770 m tons), and $3.1 million for atmospheric carbon dioxide removal (76,000 m tons). Hence, the total annual value of these three environmental benefits averages about $11 per tree, or 12% of the estimated total annual benefit of $90 per tree (Table 1). The remaining benefits, calculated to average about $79 per tree, are related to forest influences on human health, scenic beauty, property value, wildlife, water quality, community bonding, recreation and other benefits not already explicitly accounted for. Although the dollar value of environmental benefits produced by Sacramento's existing urban forest is substantial, the impact on total annual air pollution emissions and electricity use is modest, only a 1 to 2% reduction.

These benefits are offset by management costs. For instance, each year the Sacramento City Tree Services Division spends about $3 million to manage 150,000 street and park trees, an average of $20 per tree. This amount is relatively high compared to other cities due to the large population of overmature elms (Ulmus spp.) and sycamores (Platanus spp.) that require intensive management. Local residents are estimated to spend less on yard trees, about $5 to 10 per tree each year for watering, pruning, pest/disease control, and removal of dead trees (McPherson et al. Submitted). In addition, research is beginning to quantify costs associated with repair for tree root-related damage to sidewalks and curbs, impacts of tree shade on winter heating bills, and effects of biogenic hydrocarbon emissions from trees on smog. Although further quantification is needed, it appears that benefits produced by Sacramento's urban forest are several times greater than management costs.

Forest Service research is helping Sacramentans know what types of trees to plant where for the greatest net benefits. For example, the relative sustainability of tree species most commonly found in each Sector and most commonly sold today at nurseries was evaluated. Using data from a variety of references, each species was rated as low, medium, or

high for the following criteria: water use, disease/pest susceptibility, tolerance to ozone, biogenic hydrocarbon emission rate, pollen allergenicity, wildlife/native, heave sidewalks, pruning needs, wood strength, longevity, litter fall. This information will assist landscape architects, urban foresters, and others to select trees most likely to turn the greenery into greenbacks.

References

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Table 1.
Estimates of Total and Selected Annual Benefits From Sacramento County's Urban Forest.

Benefit Category	Annual Benefit[a] by Resource Unit	Total Value (in million $)	Avg. Benefit per Tree ($)
Total Tree Replacement Value	Annual value increase due to tree growth	544.1	90.04
Air Conditioning Saved	[b]234 GWh (2.5% of total annual electricity use)	25.0	4.17
Air Pollutant Uptake	[c]1,770 m tons (2.3% of annual emissions of NOx, SOx, PM10)	36.0	6.00
Carbon Reduction	[d]76,000 m tons (1.9% total CO2 emissions)	3.0	0.50
Totals	6 million trees	64.0	10.67

[a] This column shows calculated savings by resource unit (i.e., GWh and m ton) and percentage savings in parentheses. Percentage savings are based on the following data:
[b] Sacramento Municipal Utility District projected 1996 total electricity production of 9,500 GWh.
[c] Sacramento region air pollution emission inventories of NOx= 33,179, SOx=1,533, PM10= 51,100, total= 85,812 short tons or 77,869 metric tons.
[d] California Energy Commission report 12.7 m tons of CO2 per capita per year, or 3.5 m tons C, total= 1.13 million persons x 3.5 m tons = 4.0 million m tons.