NATURAL RESOURCES JOURNAL

Volume 51
Issue 2 *Fall*

Fall 2011

Sustainability and the Urban Forest: An Ecosystem Services Perspective

Keith H. Hirokawa

KEITH H. HIROKAWA*

Sustainability and the Urban Forest: An Ecosystem Services Perspective

ABSTRACT

Recently, urban forests have drawn attention due to interest in the idea that urban forests provide essential ecosystem services. Indeed, urban forests provide the benefits of a natural, cost-effective system of green infrastructure. Trees capture air and water pollutants, as well as provide shade, habitat, and even social structure. These services have a surprising but significant economic value, and attention to the design of urban forests can be a local means of capturing that value. From an ecosystem services perspective, the urban forest also reveals that the very existence of nature in the urban area occurs as both a conceptual and a physical construct. That is, trees in the urban area result from intention and design. This article argues that urban forestry is a local opportunity to engage in an exercise of self-determination and local identity. Urban forestry requires an investigation into the ties between the community's environmental, economic, and social needs, a realization of the potential of space and natural infrastructure, and a manipulation of the services provided by trees. Understanding the nature of urban forests as urban, contingent, and constructed empowers local governments to become ecosystem beneficiaries by effectively bringing nature into their communities.

"Urban forests don't get the recognition that natural forests do. They don't encompass sweeping vistas and magnificent views, and they rarely provide critical habitat to endangered species. But they are vital."[1]

I. INTRODUCTION

Urban forests might be considered an afterthought to the legal strides toward environmental quality and natural resources protection. Indeed, when one considers the more visible drivers of wilderness protection (preserving areas "untrammeled by man"[2]), resource manage-

---

* Assistant Professor, Albany Law School. J.D., University of Connecticut, 1998; M.A. University of Connecticut, 2003; L.L.M., Lewis and Clark School of Law, 2001. Sincere thanks go to Timothy Mulvaney and Andrew Long and for their comments on earlier drafts and my research assistants Anna Binau, Charles Gottlieb, and Luke Sledge.

1. Greg McPherson, *Value for Money . . .*, CHARTERED FORESTER, Winter 2009, at 14, 14, *available at* http://www.fs.fed.us/psw/programs/uesd/uep/products/cufr_787_CharteredForesterWinter2009Feature.pdf.

2. *See generally* Wilderness Act of 1964, § 2(c), 16 U.S.C.A. § 1131 (West 2011).

ment (biodiversity protection and sustainable access to natural resources), and pollution control (minimizing risks to human health), urban forests may seem an unlikely fit, both due to the purposes of the urban forest and compatibilities of scale. Moreover, although urban areas are constantly expanding, urban forests may be perceived as comprising a very small fraction of the vegetated cover of the planet,[3] making a comparatively insignificant contribution to global carbon sequestration, and producing an almost unnoticeable source of commodity goods.[4] Against this backdrop, it is understandable that trees in urban areas have historically played a limited role in the environmental quality agenda.

Urban forests have recently captured the attention of researchers of various disciplines and governments at many levels. Of course, tree aesthetics and symbolism have long been considerations of municipal planning.[5] However, the explosion of interest in urban forests diverges from mere aesthetics. Contemporary urban forest planning is premised on the idea that urban forests provide essential green infrastructure services in controlling pollution and other environmental quality challenges in the urban area.[6] In addition, foresters have recognized that forest conversion through urbanization is a significant factor affecting the potential for trees to play a role in societal adaptation and mitigation to climate change. This trend invokes the science and economics of ecosystem services.[7]

---

3. Urban forests in the United States currently remove only a small fraction of the world's carbon output. Cheryl Kollin & James Schwab, *Bringing Nature into the City*, *in* PLANNING THE URBAN FOREST: ECOLOGY, ECONOMY, AND COMMUNITY DEVELOPMENT 1, 18 (James Schwab ed., 2009).

4. *See generally* STEVE BRATKOVITCH, JIM BOWYER, KATHYRN FERNHOLZ, & ALISON LINDBURG, URBAN TREE UTILIZATION AND WHY IT MATTERS (2008), *available at* http://www.fs.fed.us/ucf/supporting_docs/DovetailUrban0108ig.pdf.

5. *See generally* Henry W. Lawrence, *The Neoclassical Origins of Modern Urban Forests*, 37 FOREST & CONSERVATION HIST. 26 (1993) (discussing the various purposes, goals, and symbolism of the urban forest).

6. Some have suggested that urban forest planning began as a regenerative effort following the sweeping effect of tree diseases in the later twentieth century, after which the U.S. Forest Service launched a focused effort to incentivize forest research and planning in urban areas. *See, e.g.*, Kollin & Schwab, *supra* note 3, at 3 (noting the disastrous effects on urban forests from Dutch Elm Disease in the 1960s and 70s). Others note that the recent interest stems from present condition of urban trees, many of which are approaching an age at which human health hazards are an issue. *See, e.g.*, S.F. URBAN FORESTRY COUNCIL & DEP'T OF THE ENV'T, URBAN FOREST PLAN: CITY & COUNTY OF SAN FRANCISCO 5 (April 2006), *available at* http://www.sfenvironment.org/downloads/library/urbanforestplanmay06.pdf.

7. The term "ecosystem services" refers to "a wide range of conditions and processes through which natural ecosystems, and the species that are part of them, help sustain and fulfill human life." Gretchen C. Daily et al., *Ecosystem Services: Benefits Supplied to Human*

Ecosystem services present an emerging form of analysis that requires the cooperation of ecology and economics. In this scheme, natural processes are recognized not only for producing those goods that have commodity value but also for non-commodity goods (such as snail darters), unvalued services (such as spiritual fulfillment and biodiversity regulation[8]), and undervalued services (such as water filtering and provision). These goods and services, which are essential to human well-being,[9] have largely been ignored in economic valuations of natural resources.[10] What is unique about ecosystem services research is that its exercise of identifying the vast array of services essential to human well-being results in an analysis of the value of preserving ecosystem functionality. The complex functionality of ecosystems provides insights into

---

Societies by Natural Ecosystems, 2 ISSUES IN ECOLOGY 1, 2 (1997), *available at* http://www.sierraforestlegacy.org/Resources/Conservation/FireForestEcology/ForestEconomics/Economics-Daily97.pdf. Robert Costanza and his colleagues define the term with a similar appeal to functionality: "Ecosystem functions refer variously to the habitat, biological or system properties or processes of ecosystems. Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions." Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253, 253 (1997), *available at* http://www.nature.com/nature/journal/v387/n6630/pdf/387253a0.pdf.

8. Even with the methodological trends and developments in ecosystem services, biodiversity and spiritual fulfillment have been difficult to value. Nevertheless, researchers have explored ways to capture the value of biodiversity in economic terms. *See, e.g.*, PAVAN SUKHDEV ET AL., THE ECONOMICS OF ECOSYSTEMS & BIODIVERSITY, MAINSTREAMING THE ECONOMICS OF NATURE: A SYNTHESIS OF THE APPROACH, CONCLUSIONS AND RECOMMENDATIONS OF TEEB 20 (2010), *available at* http://www.teebweb.org/LinkClick.aspx?fileticket=bYhDohL_TuM%3d&tabid=924&mid=181.

9. As the *Millennium Ecosystem Assessment* reports: "Ecosystem services are the benefits people obtain from ecosystems. These include *provisioning services* such as food, water, timber, and fiber; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling . . . . The human species, while buffered against environmental changes by culture and technology, is fundamentally dependent on the flow of ecosystem services." MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS, at v (2005), *available at* http://www.maweb.org/documents/document.356.aspx.pdf.

10. The Environmental Protection Agency (EPA) recently acknowledged that its regulation of environmental quality has been so fractured as to omit ecosystem services. EPA SCI. ADVISORY BD., VALUING THE PROTECTION OF ECOLOGICAL SYSTEMS AND SERVICES 8 (May 2009). Robert Costanza and Herman Daly have pointed out that one explanation for our omission of natural capital from analysis of capital assets "has been the tenet of neoclassical economic theory that human-made capital is a near-perfect substitute for natural resources, and hence for the natural capital that generates the flow of natural resources." Robert Costanza & Herman E. Daly, *Natural Capital and Sustainable Development*, 6 CONSERVATION BIOLOGY 37, 40 (1992).

both the economic and social value of these services. This perspective alters our understanding of nature "from amenity to living technology."[11]

This article argues that the ecosystem services perspective presents local governments with opportunities to practice effective self-determination and good governance. The choices that local governments make regarding whether, and to what extent, urban forests should be protected tell a great deal about the manner in which the particular community calculates the value and benefits of natural features. What makes urban trees so important to the question of local identity is in the nature of the urban forest: The urban forest is fundamentally, and in some ways uniquely, a local community choice.[12] Thus, urban forest planning is an investigation into the ties between the community's environmental, economic, and social needs, a realization of the potential of space and natural infrastructure, and ultimately, an exercise in the manipulation of forest ecosystems to maximize the services provided by trees.

II. ECOSYSTEM SERVICES OF URBAN FORESTS

Urban forests are recent arrivals to the environmental quality dialogue. In part, attention to urban forests arises as an element of nonpoint source pollution, a nagging problem that has proven to be a significant challenge for the pollution control laws arising in the 1970s.[13] "Green infrastructure" offers mitigation for nonpoint source pollution due to the manner in which trees capture and filter stormwater before it becomes a pollution problem.[14] As with forests in general, urban forests are gaining attention as a tool in climate change strategies due to the ability of trees

11. E. Gregory McPherson, *Accounting for Benefits and Costs of Urban Greenspace*, 22 LANDSCAPE & URBAN PLANNING 41, 41 (1992).

12. Hence, Henry Lawrence begins his analysis of the origins of urban forests: "[T]rees in cities are cultural expressions." Lawrence, *supra* note 5, at 26.

13. League of Wilderness Defender/Blue Mountains Biodiversity Project v. Forsgren, 309 F.3d 1181, 1184 (9th Cir. 2002) ("[a]lthough nonpoint source pollution is not statutorily defined, it is widely understood to be the type of pollution that arises from many dispersed activities over large areas, and is not traceable to any single discrete source."). *See, e.g.*, A. Dan Tarlock, *Land Use Regulation: The Weak Link in Environmental Protection*, 82 WASH. L. REV. 651, 654–57 (2007) (discussing the failures of environmental regulation in addressing nonpoint source pollution).

14. "Green infrastructure" has been defined as "[a]n interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife." MARK A. BENEDICT & EDWARD T. MCMAHON, GREEN INFRASTRUCTURE: LINKING LANDSCAPES AND COMMUNITIES 1 (2006), *quoted in* Kollin & Schwab, *supra* note 3, at 3.

to capture air pollutants.[15] In addition, urban ecosystems suffer particular problems resulting from the intensity of urban development and place-dependent changes:

> The expansion and development of urban areas over time brings important changes in vegetation and other resources. Alterations to the distribution of land uses, intensity of urbanization, and urban population characteristics result in different combinations of ground cover types (e.g., mixes of vegetation and artificial surfaces), increased/decreased opportunities for tree establishment and growth, changing environmental conditions, different resource-use patterns, and altered management objectives over time. New developments in transportation technology, or manufacturing and service industries can bring considerable change to the condition, function, and management of urban lands and associated resources. Changes in neighborhood residents can also prompt different approaches to the management of forests in residential areas, parks, and other open spaces. Further, the introduction of exotic plants and animals into interstate and international trade centers can have a profound influence on the urban forest, as evidenced by Dutch elm disease, gypsy moth, and the Asian longhorned beetle.[16]

Yet, the location of urban forests is also relevant to the services they can provide; urban forests are urban, and as such, are uniquely situated to provide services to a large, concentrated population.[17] Urban forests may be gaining ground in the environmental dialogue because of their potential to close equity gaps by offering convenient access to nature to a broad spectrum of the population.[18] With these principles in mind, the goal of urban forestry planning is to capture forest ecosystem services in

---

15. JOHN F. DWYER ET AL., U.S. DEP'T OF AGRIC. FOREST SERV., CONNECTING PEOPLE WITH ECOSYSTEMS IN THE 21ST CENTURY: AN ASSESSMENT OF OUR NATION'S URBAN FORESTS 2 (2000).

16. John F. Dwyer & David J. Nowack, *A National Assessment of the Urban Forest: An Overview*, *in* PROCEEDINGS OF THE SOCIETY OF AMERICAN FORESTERS 157, 159 (Sept. 1999).

17. As noted in the *Millennium Ecosystem Assessment*, "[a]lmost half of the world's population now lives in urban areas, and this proportion is growing. Urban development often threatens the availability of water, air and water quality, waste processing, and many other qualities of the ambient environment that contribute to human well-being, and this degradation is particularly threatening to vulnerable groups such as poor people." MILLENNIUM ECOSYSTEM ASSESSMENT, *supra* note 9, at 60.

18. Frances E. Kuo, *The Role of Arboriculture in a Healthy Social Ecology*, 29 J. ARBORICULTURE 148, 149 (2003).

ways that benefit human environmental, social, and economic needs in urban areas.[19]

A. The Ecological Services Provided by Trees

Governments at all levels are just beginning to realize the expansive importance of trees in the urban environment. In addition to the aesthetic benefits of vegetative surroundings, "[t]he effects of the urban forest on the physical, biological, and social environments can ripple from the inner city to the farthest reaches of wilderness."[20] Urban forests provide wildlife habitat, protection from wind, and local soil stability. They are also essential in providing certain services relevant to the mitigation of urbanization and other anthropogenic impacts.[21]

For instance, trees help mitigate the water quality deterioration caused by urbanization. Water bodies are threatened by disproportionate ratios of impervious surface and trees. The collection of stormwater on impervious surfaces and its transportation to water courses result in water temperature increases and the discharge of a variety of pollutants, such as oil and antifreeze from roadways and driveways, fertilizers, pesticides, and garbage. An increase in water temperature poses a challenge to temperature-sensitive species, such as trout and small invertebrates. Pollutants can accelerate algal blooms and other consequences of nutrient imbalances. Trees mitigate these urban effects by reducing and filtering stormwater runoff flows. Stormwater can be intercepted by leaves, branches, and trunks, or it can return to the atmosphere through evaporation, or it can even percolate.[22] As a result, urban trees reduce the volume of water needing containment and treatment under many development regulatory schemes. These services are particularly important in riparian corridors, where trees serve a variety of functions rang-

---

19. Urban forestry has been defined as "a planned and programmatic approach to the development and maintenance of the urban forest, including all elements of green infrastructure within the community, in an effort to optimize the resulting benefits in social, environmental, public health, economic, and aesthetic terms, especially when resulting from a community visioning and goal-setting process." Kollin & Schwab, *supra* note 3, at 3.

20. DWYER ET AL., *supra* note 15, at 3.

21. Even in urban areas, trees are significant for their roles in providing a functional habitat for a diversity of species of wildlife. As noted by the New York Legislature: "Trees and shrubs can improve the quality of urban environments by helping to prevent erosion, by providing shade, modifying extremes of temperature and humidity, helping to reduce noise and air pollution, and enhancing the aesthetic quality of life . . . . [V]egetation in urban green space can contribute to urban water shed management and provide habitats for desirable urban wildlife." N.Y. ENVTL. CONSERVATION L. § 53-0301(3) (2011).

22. Kollin & Schwab, *supra* note 3, at 4.

ing from erosion control, water flow, and water quality regulation to the provision of shade, shelter, and foraging and breeding areas for wildlife.

Research also shows that productive management of urban tree canopy cover results in air quality improvements and can help local governments in meeting federal clean air standards.[23] Air quality is a concern for all local governments but it is a particular challenge in urban areas where cities and regions struggle to meet air quality standards. Trees are capable of removing a variety of pollutants from the air, including (but not limited to) nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), and particulate matter (PM10).[24] In addition to removing pollutants, trees also release oxygen and reduce atmospheric carbon by absorption.[25] Although some of these removal functions are temporary (occasionally resulting in re-disbursement of atmospheric particles) and are limited by the potential volume of pollutant capture in any particular urban tree, the air quality impacts of urban trees are nonetheless significant and can be increased by productive attention to urban tree canopy cover.[26]

Trees also provide services in the form of energy conservation and climate control.[27] As a direct benefit, trees intercept sunlight before it reaches buildings and surfaces that radiate heat, such as asphalt and brick. Trees provide shade and cooling for both the outside and inside of the buildings they cover, thereby reducing the energy required for air conditioning and other artificial climate-control technologies. Moreover, trees provide water vapor cooling through evapotranspiration, and other cumulative and indirect climate benefits, such as by mitigating heat island effect[28] and helping protect and maintain grey infrastructure elements.[29]

---

23. David J. Nowak, Daniel E. Crane, & Jack C. Stevens, *Air Pollution Removal by Urban Trees and Shrubs in the United States*, 4 URBAN FORESTRY & URBAN GREENING 115 (2006).

24. *Id*. Kollin & Schwab, *supra* note 3, at 6–7.

25. David J. Nowak & Daniel E. Crane, *Carbon Storage and Sequestration by Urban Trees in the USA*, 116 ENVTL. POLLUTION 381, 381 (2002).

26. Nowak, Crane & Stevens, *supra* note 23, at 122.

27. Kollin & Schwab, *supra* note 3, at 5–6.

28. EPA explains the concept of "heat island effect" as: "Many urban and suburban areas experience elevated temperatures compared to their outlying rural surroundings; this difference in temperature is what constitutes an urban heat island. The annual mean air temperature of a city with one million or more people can be 1.8 to 5.4°F (1 to 3°C) warmer than its surroundings, and on a clear, calm night, this temperature difference can be as much as 22°F (12°C)." EPA, REDUCING URBAN HEAT ISLANDS: COMPENDIUM OF STRATEGIES 1 (2008), *available at* http://www.epa.gov/heatisld/resources/pdf/BasicsCompendium.pdf.

29. E. Gregory McPherson & Jules Muchnick, *Effects of Street Tree Shade on Asphalt Concrete Pavement Performance*, 31 J. ARBORICULTURE 303, 308 (2005) (finding a correlation between tree shade and better performance of pavement). Examples of grey infrastructure

B. Social Services of Urban Trees

In addition to these physical benefits, trees also offer significant social, cultural, and spiritual services in urban areas. First, the social importance of trees is clearly evidenced by their power and pervasiveness as spiritual and cultural icons.[30] Urban trees, which provide an aesthetic value beyond objective quantification,[31] "can turn city blocks into special places—places for residents to recreate, to gather with family and friends, and to care about."[32] Although difficult to quantify, urban forests provide a meaningful opportunity for outdoor recreation and interaction with nature.

Second, urban forests offer access to personal experiences with nature. Because urban forests are experienced on a regular basis, the less-tangible benefits of interacting with forests in urban areas can be equivalent to, or even more satisfying than, the wilderness experience.[33] Moreover, living in the urban forest may be the only forest experience for many urban dwellers,[34] as "[t]he symbolic nature of place features contribute to a resident's extended self, place identity and ultimately,

---

include roads and bridges, utility lines, and telecommunication facilities. Examples of green infrastructure might include natural land and ecosystem features, such as wetlands and their capacity to provide clean water, serve as habitat, recharge groundwater, and reduce flood hazards. *E.g.*, GREEN INFRASTRUCTURE PLAN FOR SARATOGA COUNTY 1 (2006), *available at* http://www.saratogaplan.org/documents/FullPlan_LessApp.pdf ("Like the highways, water, sewer, and electric lines and other built or 'grey' infrastructure, 'green' infrastructure is the network of natural landscapes including forests, farmlands, parks and preserves.").

30. *See generally* FRED HAGENDER, THE MEANING OF TREES (2005) for a discussion about the different and often divergent symbolic, spiritual, and cultural roles played by trees.

31. *See* Richard E. Chenowith & Paul H. Gobster, *The Nature and Ecology of Aesthetic Experience in the Landscape*, 9 LANDSCAPE J. 1, 1 (1990) (testing the assumption "that beautiful landscapes provide unique opportunities for people to achieve special kinds of experiences, often called 'aesthetic,' that are highly valued and less likely to occur in less-beautiful places," and finding that urban forest managers should take aesthetic value into account when designing forest resources.).

32. DWYER, ET AL., *supra* note 15, at 3.

33. Chenowith & Gobster, *supra* note 31; *see generally* R. Bruce Hull, *How the Public Values Urban Forests*, 18 J. ARBORICULTURE 98 (1992), *available at* http://www.sfrc.ufl.edu/urbanforestry/Resources/PDF%20downloads/Hull_values_1992.pdf (explaining that following Hurricane Hugo in South Carolina, over 30 percent of respondents stated that the forest destruction had been the most significant even though many churches, historical structures, and homes were destroyed. These results also indicated the numerous and diverse values that humans associate with forests.).

34. David J. Nowak, Mary H. Noble, Susan M. Sisinni, & John F. Dwyer, *Assessing the US Urban Forest Resource*, 99 J. FORESTRY 37, 38 (2001), *available at* http://nrs.fs.fed.us/pubs/jrnl/2001/nc_2001_Nowak_001.pdf.

self identity."[35] As such, trees can provide psychological and spiritual benefits in urban areas.

Third, health-related benefits illustrate the profound importance of trees and tree services in urban areas. Skin cancer, asthma, and obesity are on the rise, and trees offer protective and preventative services against these problems.[36] Shade from trees reduces sun exposure. Air pollutant filtering mechanisms in trees can reduce the stressors that trigger asthma. In addition, studies show that the mere presence of trees increases the frequency of outdoor recreation, particularly in children, assisting in the fight against the obesity epidemic.[37] These benefits are of course location dependent, yet urban forests "occur where the vast majority of the human population lives, works, and recreates,"[38] and are more accessible to most than the more "wild" or "natural" experiences offered by wilderness areas, national parks, and national monuments.

Despite these potential benefits, not all communities are so accommodating of the movement toward revitalizing urban forests.[39] For instance, urban forests have been questioned on grounds of safety, with housing authority managers and police suggesting that trees can reduce visibility,[40] thereby creating sheltered areas for the commission of

35. Hull, *supra* note 33, at 99.

36. *See* Kollin & Schwab, *supra* note 3, at 7–9.

37. Gilbert C. Liu, et al., *Green Neighborhoods, Food Retail and Children Overweight: Differences by Population Density*, 21 AM. J. HEALTH PROMOTION 317, 322 (2007), *available at* http://www.goforyourlife.vic.gov.au/hav/admin.nsf/Images/Green_Neighborhoods.pdf/$File/Green_Neighborhoods.pdf; Janice F. Bell, et al., *Neighborhood Greenness and 2-Year Changes in Body Mass Index of Children and Youth*, 35 AM. J. PREVENTATIVE MED. 547, 551–52 (Dec. 2008), *available at* http://sfgov3.org/ftp/uploadedfiles/shapeupsf/research_data/Neighborhood_Greenness.pdf.

38. DWYER, ET AL., *supra* note 15, at 3. *See also*, David J. Nowak et al., *The Increasing Influence of Urban Environments on US Forest Management*, J. FORESTRY 377, 380 (2005), *available at* http://www.fs.fed.us/ne/newtown_square/publications/other_publishers/OCR/ne_2005_nowak002.pdf.

39. *See, e.g.*, UNITED NATIONS ENVIRONMENT PROGRAMME 2010, *The Greening of Water Law: Managing Freshwater Resources for People and the Environment* xi-xii (2010), *available at* http://www.unep.org/delc/PDF/UNEP_Greening_water_law.pdf (noting that the trend toward greening water law is significant but not universal. "[B]ecause the green approach to water regulation does not always result in immediate societal benefits, governments also face political and economic obstacles in seeking to realign medium and long-term water management strategies rather than providing for the immediate needs of their citizens.").

40. Kuo, *supra* note 18, at 149.

crimes.[41] Other concerns relate to fears of the wilderness, becoming lost, and natural threats such as Lyme disease.[42]

However, others contend that these fears are irrational and misplaced. In their study of Chicago's inner-city apartment buildings, researchers Frances Kuo and William Sullivan concluded that buildings set in green settings tend to experience at least 40 percent lower crime rates than those buildings that have no greenery.[43] Contrary to the general feeling that shadows harbor criminal intentions, these researchers found that trees in urban areas may reduce aggression and violence by projecting inclusion, rather than alienation.[44] In a separate study, Kuo reported:

> Trees and grass cover were linked with greater use of residential outdoor spaces by adults and children, healthier patterns of children's outdoor activity, more social interaction among adults, healthier patterns of adult-child interaction and supervision, stronger social ties and greater resource-sharing among adult residents, greater sense of safety and adjustment, lower levels of graffiti and other signs of social disorder, fewer property crimes, and fewer violent crimes.[45]

Furthermore, trees provide a basis for valuing local communities and improving residents' perceptions on the value of environmental quality.[46] With a greater frequency than in treeless areas, communities take advantage of green spaces to congregate and socialize, as well as recreate together, creating stronger community ties and networks.[47] Such participation can lead to greater security and decreased incidents of crime,[48] perhaps resulting from a greater sense of stake and empowerment.[49] In addition, vegetation in neighborhoods appears to have a posi-

---

41. Sean E. Michael, R. Bruce Hill & Diane L. Zahm, *Environmental Factors Influencing Auto Burglary: A Case Study*, 22 ENV'T & BEHAV. 368, 369 (2001).

42. John F. Dwyer, Herbert W. Schroeder, & Paul H. Gobster, *The Significance of Urban Trees and Forests: Toward a Deeper Understanding of Values*, 17 J. ARBORICULTURE 276, 281 (1991), *available at* http://www.ncrs.fs.fed.us/pubs/jrnl/1991/nc_1991_dwyer_001.pdf.

43. Frances E. Kuo & William E. Sullivan, *Environment and Crime in the Inner City: Does Vegetation Reduce Crime?*, 33 ENV'T & BEHAV. 343, 355 (2001).

44. *Id.* at 360–61.

45. Kuo, *supra* note 18, at 152.

46. Dwyer, *supra* note 42, at 276.

47. William C. Sullivan, Frances E. Kuo, & Stephen F. DePooter, *The Fruit of Urban Nature: Vital Neighborhood Spaces*, 36 ENV'T & BEHAV. 678, 679–680 (2004), *available at* http://www.outdoorfoundation.org/pdf/FruitOfUrbanNature.pdf; *see also* Kuo, *supra* note 18, at 148.

48. Kuo & Sullivan, *supra* note 43, at 360–61.

49. Lynne M. Westphal, *Urban Greening and Social Benefits: A Study of Empowerment Outcomes*, 29 J. ARBORICULTURE 137, 138 (May 2003), *available at* http://www.treelink.org/joa/2003/may/03westphal.pdf.

tive impact on rental rates,[50] driver stress,[51] workplace productivity,[52] childhood development,[53] and health recovery.[54] As such, Kuo and Sullivan support strong associations between urban trees and desirable social consequences but also between trees and the other forms of social capital, which create social and individual development opportunities.

C. Economic Valuation of Urban Forest Services

As discussed above, the ecosystem services analysis begins with an examination of functional ecosystems and the services they provide. However, the dividends of a deep understanding of ecosystem functionality are found in the resulting grasp of the relationship between ecosystems and economic value. Not surprisingly, the recent preference of applying ecosystem services analysis to urban forests is a substantial shift.

Many local tree planting and protection programs began as part of the City Beautiful movement a century ago.[55] Some continued these programs as a means of maintaining aesthetic standards and minimizing the

---

50. *See generally* Robert J. Laverne & Kimberly Winson-Geideman, *The Influence of Trees and Landscaping on Rental Rates at Office Buildings*, 29 J. ARBORICULTURE 281 (2003), *available at* http://www.skyhorsestation.com/pdf/article_trees_cmrcialbldgs.pdf.

51. Jean Marie Cackowski & Jack L. Nasar, *The Restorative Effects of Roadside Vegetation: Implications for Automobile Driver Anger and Frustration*, 35 ENV'T & BEHAV. 736, 738 (2003), *available at* http://facweb.knowlton.ohio-state.edu/jnasar/crpinfo/research/RoadsideEB2003.pdf.

52. Rachel Kaplan, *The Role of Nature in the Context of the Workplace*, 26 LANDSCAPE & URBAN PLANNING 193, 199 (1993), *available at* http://deepblue.lib.umich.edu/bitstream/2027.42/30542/1/0000175.pdf.

53. Andrea Faber Taylor, Frances E. Kuo & William C. Sullivan, *Coping with ADD: The Surprising Connection to Green Play Settings*, 33 ENV'T & BEHAV. 54, 58, 70–72 (2001), *available at* http://www.outdoorfoundation.org/pdf/CopingWithADD.pdf; Nancy M. Wells, *At Home with Nature: Effects of "Greenness" on Children's Cognitive Functioning*, 32 ENV'T & BEHAV. 775, 780–82 (2000), *available at* http://www.sfrc.ufl.edu/urbanforestry/Resources/PDF%20downloads/Wells_2000.pdf.

54. Roger S. Ulrich, *View Through a Window May Influence Recovery from Surgery*, 224 SCIENCE 420, 421 (1984), *available at* http://www.hospitalart.com/image/science_article.pdf.

55. *See, e.g.*, S.F. URBAN FORESTRY COUNCIL, *supra* note 6; *see also* Judith S. Kaye, et al., *Sidewalk Trees and the Law*, 81 N.Y. ST. B.J. 24, 25 (2009) (discussing the public value in beautifying cities through tree plantings seen in the City Beautiful movement); Vanessa Russell-Evans & Carl. S. Hacke, *Expanding Waistlines and Expanding Cities: Urban Sprawl and Its Impact on Obesity, How the Adoption of Smart Growth Statutes Can Build Healthier and More Active Communities*, 29 VA. ENVTL. L.J. 63, 72 (2011) (explaining that "[t]he City Beautiful Movement was another important event set off by the unhealthy living conditions of industrial cities. Bringing air, light, and green space back into the city was the basic underlying value of this movement.").

nuisance effects of uncontrolled weed growth in urban areas.[56] Yet these past tree-planting programs, based on older quality-of-life models and outdated ecosystem beliefs, arguably created the circumstances that make an ecosystem services perspective so compelling today.

By applying the ecosystem services analysis, local communities can understand the value that a functioning ecosystem adds to land—in some cases, by comparing the cost of losing various ecosystem services. For example, in the case of Cheyenne, Wyoming, the U.S. Forest Service was asked "whether the accrued benefits from Cheyenne's street trees justify the annual expenditures?"[57] According to the resulting report, Cheyenne's street trees were found to improve property values, provide a sense of place, improve air and water quality, and reduce energy costs, thus resulting in quantifiable benefits:

> The municipal tree resource of Cheyenne is a valuable asset, providing approximately $686 thousand ($40/tree) in total annual benefits to the community. The city currently spends approximately $19/tree on their care. Over the years Cheyenne has invested millions in its municipal forest. Citizens are now receiving a relatively large return on that investment—receiving $2.09 in benefits for every $1 spent on tree care. Continued investment in management is critical to insuring that residents receive a greater return on investment in the future.[58]

In the analysis of urban tree services in Bellevue, Washington, the nonprofit conservation group American Forests estimated that Bellevue enjoys 46 percent canopy cover.[59] However, between 1986 and 2006, the city lost approximately 21 percent of its canopy cover while adding 20 percent to urbanized areas.[60] American Forests estimated this resulted in a loss of air pollutant removal services at 30,000 pounds annually, valued

---

56. Such nuisance control schemes have been typically upheld under the police power. *But see* Baton Rouge Audubon Soc'y v. Sandifer, 702 So.2d 997, 1001 (3rd Cir. 1997) (holding enforcement of vegetation maintenance against property dedicated to restoring and protecting chenier habitat for migratory songbirds by Audubon Society ordinance arbitrary and capricious) and Stevens v. City of Salisbury, 214 A.2d 775, 783 (Md. 1965) (finding it unreasonable to require private property owners to maintain vegetation without a showing of public need).

57. PAULA J. PEPER ET AL., USDA FOREST SERVICE, CITY OF CHEYENNE, WYOMING MUNICIPAL TREE RESOURCE ANALYSIS 8 (2004), *available at* http://www.fs.fed.us/psw/programs/cufr/research/studies_detail.php?ProjID=151.

58. *Id.* at 9–10.

59. AMERICAN FORESTS, URBAN ECOSYSTEM ANALYSIS: CITY OF BELLEVUE, WASHINGTON 3 (Oct. 2008), *available at* http://www.americanforests.org/downloads/rea/AmforReport_Bellevue_lowres.pdf.

60. *Id.*

at $68,000 per year.[61] The loss also required Bellevue to handle an additional 755,000 cubic feet of stormwater, at an additional cost of $1.5 million.[62]

In a study of Charlotte, North Carolina, American Forests noted that the last 23 years of urban tree loss had been devastating to the ecosystem services that benefited residents. The report noted:

> Between 1985 and 2008, Mecklenburg County lost 33% tree canopy and 3% open space while gaining 60% urban area . . . . In the same time period, the City of Charlotte lost 49% tree canopy and 5% open space while gaining 39% urban area.[63]

In 2008, Charlotte's tree canopy covered 46 percent of its jurisdiction, providing 662 million cubic feet of stormwater detention.[64] Charlotte's urban forests also removed 7.2 million pounds of air pollutants, stored 3.7 million tons of carbon, and sequestered 28,000 tons of carbon.[65] Valuation for these services, based on the cost of constructing other means to accomplish these services, were $1.3 billion for stormwater detention and $19.2 million per year for air pollutant removal.[66]

The climate in Albuquerque, New Mexico, supports a much lower ratio of tree canopy and vegetative cover, in which canopy is estimated at only 6 percent of the jurisdiction.[67] Nevertheless, American Forests reported that between 1990 and 2008, Albuquerque lost approximately 7 percent of its tree cover (43 acres), 24 percent of open space grasslands (3,569 acres), and 23 percent of scrub lands (11,586 acres), while converting 15,169 acres into urbanized area.[68] On the whole, American Forests estimates this loss included the ability to remove 3,000 pounds of air pollutant annually, valued at $6,800 per year, the need to treat or construct retention facilities for 31 million cubic feet of stormwater (valued at $6 per cubic foot), and the ability to absorb a variety of waterborne

---

61. *Id.* at 2.

62. *Id.* at 3 (explaining that American Forests used a stormwater retention facility construction cost of $2 per cubic foot, but the local costs for stormwater retention were anecdotally estimated at $10 per cubic foot).

63. AMERICAN FORESTS, URBAN ECOSYSTEM ANALYSIS: MECKLENBURG COUNTY AND THE CITY OF CHARLOTTE, NORTH CAROLINA 2–3 (Apr. 2010), *available at* http://www.americanforests.org/downloads/rea/AF_Charlotte_2010.pdf.

64. *Id.* at 3.

65. *Id.*

66. *Id.*

67. AMERICAN FORESTS, URBAN ECOSYSTEM ANALYSIS: ALBUQUERQUE, NEW MEXICO 3 (May 2009), *available at* http://www.americanforests.org/downloads/rea/Alb_5%2022.pdf.

68. *Id.* at 5.

pollutants, including biochemical oxygen demand (BOD), cadmium, zinc, lead, nitrogen, phosphorous, and suspended solids.[69]

Although the economic valuation of urban forest ecosystem services is still emerging,[70] the rise in ecosystem services analysis is proving self-perpetuating. As one report notes, "[t]he valuation of ecosystem services has stimulated the implementation of policies that reward those responsible for protecting those services,"[71] suggesting the likelihood that an ecosystem services approach will continue to grow and dominate urban forestry programs.[72] At least, interest in tree services will continue to grow as carbon sequestration continues to gather momentum in dialogues concerning climate change and greenhouse gas emissions.[73] Of course, urban trees are not without their own costs, including planning,

---

69. *Id.* at 3.

70. Given both the complexity of ecosystem services and the remaining uncertainties in the analysis attributable to lack of sufficient study, economic valuations of ecosystem services are typically given low estimates. *See generally* Robert Costanza, et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253 (1997), *available at* http://www.uvm.edu/giee/publications/Nature_Paper.pdf. Foresters and arborists continue to refine the ecosystem services methodology to insure that the economic and human well-being effects of urban forests are accurately accounted. The project is challenging, as forest structure is essential in understanding the level of services provided, and "the most precise way to assess urban forest structure is to measure and record information on every tree." David J. Nowak, et al., *A Ground-Based Method of Assessing Urban Forest Structure and Ecosystem Services*, 34 ARBORICULTURE & URBAN FORESTRY 347, 347 (2008), *available at* http://www.itreetools.org/eco/resources/08%20UFORE.pdf.

71. SUKHDEV ET AL., *supra* note 8.

72. The influence of ecosystem services in forest management might also be attributable to the growing sphere of the urban forest. *See*, David J. Nowak & Jeffrey T. Walton, *Projected Urban Growth (2000–2050) and Its Estimated Impact on the US Forest Resource*, J. FORESTRY 383, 388 (2005) ("The management objectives of urban forestry often are not commodity based, rather they are service-based; and sustaining healthy, long-lived, functioning tree canopy is a primary objective of urban forest management. Thus, as the landscape becomes more urbanized, forest management objectives likely will shift from commodity-based management toward more ecosystem services."), *available at* http://www.fs.fed.us/ucf/supporting_docs/Nowak_Walton_JoF_Dec_2005.pdf.

73. *See generally* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CARBON DIOXIDE CAPTURE AND STORAGE: SUMMARY FOR DECISION MAKERS (Bert Mertz et al. eds., 2005), *available at* http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf; NICHOLAS STERN, STERN REVIEW ON THE ECONOMICS OF CLIMATE CHANGE (2006), *available at* http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/Independent_Reviews/stern_review_economics_climate_change/sternreview_index.cfm; David J. Nowak & Daniel E. Crane, *Carbon Storage and Sequestration by Urban Trees in the USA*, 116 ENVTL. POLLUTION 318 (2002), *available at* http://nrs.fs.fed.us/pubs/jrnl/2002/ne_2002_nowak_002.pdf (providing an overview of the capacities of urban trees to contribute to carbon control strategies).

maintenance, and hazard control.[74] On balance, however, the evidence suggests that local governments are enjoying substantial returns on their tree investments.

III. THE RELEVANCE OF URBAN FORESTS TO COMMUNITY GOVERNANCE

Up to this point, this article has merely surveyed the benefits of urban forests to illustrate that, from an ecosystem services perspective, the question "what is the urban forest" can be (or should be) answered by reference to the services the particular ecosystem provides. The ecosystem services analysis provides insightful and vital information to local governments that are engaged in landscape and environmental management choices. Yet other important, unanswered questions linger, including, what are the consequences of casting urban forests and urban forest ecosystems as subjects of local choice about local governance?

When communities recognize that the services provided by an urban forest ecosystem are valuable, they confront their dependency on a functional ecosystem.[75] Yet a deeper analysis—one that considers the ecological, economic, and social dimensions of an urban forest—may require localities to face, and ultimately adopt, the idea of nature as a local manipulation.

Some time ago, when questioning the feasibility of preserving environmentally sensitive areas, urban-design professor Martin Krieger considered this point:

> What's wrong with plastic trees? My guess is that there is very little wrong with them. Much more can be done with plastic trees and the like to give most people the feeling that they are experiencing nature. We will have to realize that the way in which we experience nature is conditioned by our society—

74. *See generally* John F. Dwyer, E. Gregory McPherson, Herbert W. Schroeder, & Rowan A. Rowntree, *Assessing the Benefits and Costs of the Urban Forest*, 18 J. ARBORICULTURE 227 (1992) ("But there are also environmental problems that may be associated with the urban forests, such as the generation of pollen, hydrocarbons, and green waste; water and energy consumption; obscured views; and displacement of native species of plants.") *Id.* at 232.

75. The relationship between community values and identity and forest ecosystems is illustrated in the evidence that urban trees have long served as symbols of nature. *See* Lawrence, *supra* note 5, at 29 (noting the symbolic meanings of city trees in the seventeenth century and that, "[a]s in gardens, the trees were symbols of nature, though the regular rows of trees and the rectangular shapes of squares were clearly nature controlled and manipulated for human pleasure, not meant to imitate wild nature."). However, it may be only recently that trees in urban areas were also intended to imitate ecosystem processes as represented in the ecosystem services analysis.

> which more and more is seen to be receptive to responsible interventions.[76]

Krieger's point is merely a constructive one: What is valued about nature is influenced by our social practices and norms and generally arises as a construct of our collective imagination. If what we value is the opportunity to engage in a "natural" experience, the degree to which we achieve this goal is largely determined by the context in which we seek the experience (or further, that we will first need to be told what constitutes such an experience).

In a sense, this is what local governments have been doing all along.[77] Manicured parks and open spaces, planted and maintained street trees, community gardens, landscape architecture, and even plastic trees are examples of intentional efforts to benefit public and private areas with some aspect of nature. However, when understood through the lens of ecosystem services, the urban forest gives a renewed importance to designing nature in order to capture the benefits of a functioning ecosystem.

First, the ecosystem services approach to urban forestry requires local governments to engage in a fundamentally local—but broad and complex—process of maximizing priorities by identifying the relative values of natural and artificial machinery in protecting the public welfare. To the extent that local governments are driven by advantages felt from local natural resource opportunities, local governments are *always* ecologically situated:

> Given the unique character of urban forests found in particular settings, effective management . . . requires different forest management strategies within an urban environment (for example, by land use, land ownership, degree of development, and population density), and among urban areas (with different ecoregions, populations, and other attributes). With the complexity of land uses, ownership, and resources, a "one-size fits all" urban forest management scheme is not appropriate for these complex ecosystems.[78]

What the local ecosystems services analysis adds is the recognition that local governments confront ecosystems precisely in the manner they are

---

76. Martin H. Krieger, *What's Wrong with Plastic Trees?*, 179 SCIENCE 446, 453 (1973).

77. "Societies cannot escape the value issue: whenever societies choose among alternative uses of nature, they indicate (at least implicitly) which alternative is deemed to be worth more." LAWRENCE H. GOULDER & DONALD KENNEDY, VALUING ECOSYSTEMS: PHILOSOPHICAL BASES AND EMPIRICAL METHODS 23 (Gretchen C. Daily ed., 1997).

78. Dwyer & Nowak, *supra* note 16, at 160.

portrayed in the ecosystem services analysis—as valuable natural capital that provide services of ecological, economic, and social importance.

When local governments engage in an ecosystem services analysis, they encounter a multidisciplinary understanding of how and whether ecosystem services are valued and valuable. By translating ecosystem functionality into an economic vocabulary, the ecosystem services approach helps communities grasp the real and long-term economic costs of its policies, such as adding more pavement, expanding urban growth areas, removing land use restrictions that require vegetated setbacks, or regulating trees on private property. This approach helps communities compare the benefits of planting trees in particular locations, limiting urban trees to particular species, funding pruning or other tree management programs, and so on.

Second, the ecosystem services analysis shows that the ability of urban forests to provide benefits to human well-being largely depends on whether communities *perceive* certain ecological services and processes as necessary and valuable. Of course, an objective component is inherent in this analysis: the urban forest relies on functioning ecological processes to produce goods and services that benefit human well-being. However, not all goods or services (and by extension, not all ecosystem processes) are perceived as having value. This suggests a constant risk that urban forests could be managed in a way that neutralizes particular benefits or interferes with ecological processes. The ecosystem services analysis improves local decision-making by requiring the identification of those ecosystem functions that have historically been taken for granted or even eliminated.[79] The analysis also provides a platform for debating the value of these otherwise ignored ecosystem functions based on the premise that human health in urban areas may be unwittingly driven by a lack of perception.

Third, the ecosystem services approach allows communities to make informed choices as nature is *designed* in urban areas. Urban forests are subject to manipulation[80] and, in practice, are manipulated to maxi-

---

79. As noted in a recent National Academy of Sciences report: "[P]roviding clear policy advice requires the simultaneous estimation of multiple ecosystem service values. Expanding the range of ecosystem services covered brings the resulting estimates of economic value closer to providing an accurate estimate of the value of all ecosystem services." WATER SCI. & TECH. BD., VALUING ECOSYSTEM SERVICES: TOWARD BETTER ENVIRONMENTAL DECISION-MAKING 172, 172 (2005).

80. *See* Greg McPherson et al., *Municipal Forest Benefits and Costs in Five U.S. Cities*, 103 J. FORESTRY 411, 411 (2005) ("The urban forest is, in part, an artificial construction, and street and park trees are its most cultivated component."); DWYER ET AL., *supra* note 15, at 3 ("A fundamental premise behind the management of urban forest resources is that humans can manipulate the structure of vegetation to enhance various forest benefits. This mechanism

mize the ecological, economic, and social benefits of urban trees.[81] Of course, short of planting plastic trees, the success of an urban forest will depend on natural processes for which human intention is largely irrelevant. Designing urban forests is dependent on tree types as well as whether a planting area is supplied with sufficient water and suitable soil conditions. Tree survival also depends on whether a planting area is supplied with sufficient water, suitable soil conditions, and a favorable grade. Nevertheless, the process of identifying the location, type, and density of tree plantings, monitoring tree health, and maintaining tree standards are design preferences tied to value-laden choices. Urban forests are "natural" in their relations to ecosystem processes but their presence is largely the result of human construction;[82] that is, urban forests are designed and managed for benefits that are valued in a very local context.[83]

---

occurs in the context of societal values (what the community wants) and ecological principles (what is ecologically possible).").

81. *See* Irus Braverman, "*Everybody Loves Trees*": *Policing American Cities Through Street Trees*,19 DUKE ENVTL. L. & POL'Y F. 81, 118 (2008) ("Although posed as a natural occurrence, the mere presence of trees in the city, as well as their particular locations and types, is therefore a much more orchestrated enterprise than it may initially seem to be."). An interesting example in which ecosystem services are relied upon to derive a substantial benefit from ecosystem processes, even if a manipulated benefit, is found in the sockeye salmon enhancement project in Tustumena Lake in the Kenai National Wildlife Refuge and Kenai Wilderness. Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 353 F.3d 1051 (9th Cir. 2003) (enjoining the project due to conflicts with the Wilderness Act).

82. Notably, in some areas the very presence of an urban forest is entirely a human construction. *See, e.g.*, S.F. URBAN FORESTRY COUNCIL, *supra* note 6, at 5 ("No forest existed prior to the European settlement of the city and the photographs and written records from that time illustrate a lack of trees. Previously, there was an Ohlone Indian population who used the native plant resource. Towards the Pacific Ocean, one saw vast dunes of sand, moving under the constant wind. While there were oaks and willows along the creeks, San Francisco's urban forest had little or nothing in the way of native tree resources."). *But see* E. GREGORY MCPHERSON, DAVID J. NOWAK & ROWAN A. ROWNTREE, U.S. DEP'T OF AGRIC. FOREST SERV., CHICAGO'S URBAN FOREST ECOSYSTEM: RESULTS OF THE CHICAGO URBAN FOREST CLIMATE PROJECT 15, 15 (1994), http://www.nrs.fs.fed.us/pubs/gtr/gtr_ne186.pdf (explaining that in some areas, such as Chicago, natural seeding is a significant method of seed dispersal. However, in such areas, it is common for cities to actively manage lands to prevent tree growth).

83. There is an obvious danger, but one that may be unavoidable, in placing so much importance on manipulation as a factor of ecosystem importance. Specifically, from the argument that human influence and values play a central role in securing ecosystem benefits, it might be concluded that ecosystem services is fundamentally a capture-oriented approach to ecosystem value, or worse, that an ecosystem service that is not locally recognized has no value at all. The first conclusion ignores the mechanism of the ecosystem services analysis, that ecosystems (manipulated or not) provide these services. Manipulation of ecosystem structure must be designed (if at all) with an understanding of the lost services that accompany ecosystem design and transformation. The second conclusion is a

What follows from the foregoing is that communities that give attention to the design of urban forests are realizing a convergence of what is natural and what is the result of intention and design. As scholar Henry Lawrence notes, "[m]ost of the trees in the urban forest owe their presence to some human activity. Human intentions therefore influenced trees' role in the urban environment and help explain historical origins."[84] Hence, the idea of an urban forest as "natural" has important consequences, but it must be further contextualized in light of both Krieger's insights[85] and the ecosystem services' process: Although the urban forest provides "natural capital," the idea that urban tree planning is intentional may open an inquiry into whether local decision-making on tree planting, maintenance, and removal is determined by the most appropriate social and political influences. Maximizing ecosystem services means that the benefits of urban forests result not just from the presence of trees in urban areas but from the presence of the most appropriate trees in culturally and ecologically significant places. Ecological dependencies that affect the value of an urban forest include topography, climate, hydrology, development history, and other local circumstances. Culturally, an analysis of the place and politics of an urban forest reveals the interplay of local circumstances to the communities that have, want, or need them. Urban forests are highly influenced by the attention given them through design, with a community's choices having far-reaching ecological, economic, and social implications.

If urban forests can be characterized as "designed nature," then the governance implications of urban forests and ecosystem services may indeed commit local governments to consider the value of plastic trees. However, in all likelihood, plastic trees will not be highly valued as compared with forest ecosystem processes.[86] Based on today's understanding

---

bit more problematic. It might be considered a failure of the ecosystem services approach if—and when—estimations of the economic value of particular ecosystem value result in the identification of certain ecosystem functions or services that are less valuable in their natural state than they would be if manipulated or even eliminated. A fuller discussion on the ethical implications of artificial substitutes is beyond the scope of this article. Nevertheless, it should be noted that the ecosystem services analysis is not intended to subsume other values that might be appreciated in natural systems. That is, arriving at an ecosystem services value does not alleviate the need to engage in an analysis of the ethical relationships and tensions between the built and natural environment.

84. Lawrence, *supra* note 5, at 26.

85. *See* Krieger, *supra* note 76.

86. As Lawrence Tribe noted, "[t]o insist on the superiority of natural trees in the teeth of a convincing demonstration that plastic ones would equally well serve human purposes may seem irrational. Yet the tendency to balk at the result of the analysis remains. There is a suspicion that some crucial perspective has been omitted from consideration, that the conclusion is as much a product of myopia as of logic." Lawrence H. Tribe, *Ways Not to*

of a forest's ecological processes and function, Krieger likely undervalued the extent to which natural ecosystems provide services essential to human well-being.[87] Arguably, Krieger also underestimated the ability of urban forestry to translate ecosystem processes into economic terms. Yet his insights on the relationship between values and perception illustrate the idea that perception remains a powerful factor in turning local circumstances into local assets. Because people interact with trees in urban areas, and because the manner in which that interaction can be controlled and planned implies something of a community meaning, urban forests can be designed in ways that build upon community, place, and identity just as urban forests can be determined by such goals.

IV. REALIZING THE POTENTIAL OF THE URBAN FOREST: LOCAL CHALLENGES, STRATEGIES, AND COMMUNITIES

Community tree planning and protection programs are becoming quite popular. To implement urban forestry principles, local governments commonly keep arborists and foresters on staff.[88] Moreover, the number of local governments seeking "Tree City USA" status from the Arbor Day Foundation[89] indicates that local governments see value in urban forest assets. Yet the wide array of programs—regulatory and planning, public and private, or only private, among others—confirms that the value of urban forestry is felt locally, and that, at the local level, urban trees are very meaningful. As noted in a recent American Planning Association publication, "[i]t is hard to imagine [the city of] Savannah without its urban forest."[90]

A significant number of tree protection ordinances are premised on a broader understanding of the ecosystem benefits of urban forests. For instance, Durham, North Carolina, recognizes that "[t]ree coverage

---

Think About Plastic Trees: New Foundations for Environmental Law, 83 YALE L.J. 1315, 1326 (1974).

87. When Krieger found "no reason to believe that . . . artificial environments need be unsatisfactory for those who experience them," Krieger, *supra* note 76, at 453, it appears that he omitted consideration of a wider understanding of the ecological services that are provided by functioning ecosystems. Rather, he appears to value only those environmental amenities that have a more obvious and direct value (even if only spiritual value). *Id.*

88. Kollin & Schwab, *supra* note 3, at 12.

89. Arbor Day Foundation, *Tree City USA Standards*, ARBORDAY.ORG, http://www.arborday.org/programs/treeCityUSA/standards.cfm (last visited May 5, 2011) (reporting that the standards for recognition under the Tree City USA program are (1) a tree board or department, (2) a tree care ordinance, (3) a community forestry program with an annual budget of at least $2 per capita, and (4) an Arbor Day observance and proclamation).

90. James Schwab, *The Principles of an Effective Urban Forestry Program*, *in* PLANNING THE URBAN FOREST: ECOLOGY, ECONOMY, AND COMMUNITY DEVELOPMENT 38, 38 (Schwab ed., 2009).

serves to reduce glare, noise, air pollution, and soil erosion; to moderate temperatures; to reduce stormwater runoff; to preserve remnants of Durham's native ecology; to provide habitat for native plants and wildlife; to provide a healthy living environment; and to make Durham County a more attractive place to live."[91] Likewise, Lake Geneva, Wisconsin, adopted a "Woodland Overlay District" to protect a wide variety of ecological functions, expressed by the city in more technical terms:

> These include atmospheric benefits such as removing airborne pollutants, carbon dioxide uptake, oxygen production, and evapotranspiration returns. Water quality benefits include substantial nutrient uptake rates (particularly for nitrogen and phosphorus) and surface runoff reduction in terms of both volumes and velocities. Woodlands provide unique wildlife habitats and food sources. Woodlands are excellent soil stabilizers, greatly reducing runoff-related soil erosion. Woodlands also serve to reduce wind velocities which further reduces soil erosion. Finally, under proper management techniques, woodlands serve as regenerative fuel sources.[92]

Other cities' tree protection schemes are similar, finding that a "healthy urban forest enhances the health and welfare,"[93] provides the economic benefits of ecosystems services,[94] promotes civic awareness and iden-

91. DURHAM CITY-COUNTY, N.C., UNIFIED DEVELOPMENT ORDINANCE § 8.3.1.A (2011).

92. CITY OF LAKE GENEVA, WIS., MUN. CODE § 98-507(2) (1997). In woodland overlay zones, owners are permitted as of right to engage in selective cutting of not more than 30 percent of the on-site woodlands, *id.* at § 98-206(f), and may seek a conditional use approval to clear cut the property when the applicant can "demonstrate that clear cutting will improve the level of environmental protection on the subject property," *id.* § 98-206(g)(2)(a).

93. CITY OF AUSTIN, TEX., ORDINANCE NO. 20100204-038, part 1(2) (2010) (ordinance amending City Code §§ 25-8(B)(1) and 6-3-48).

94. JACKSON COUNTY, FLA., CODE OF ORDINANCES § 74-201(3) (2010) ("aid[ing] in stabilizing the environment's ecological balance by contributing to the processes of air purification, oxygen regeneration, groundwater recharge, and stormwater runoff retardation, as well as aiding in noise, glare, and heat abatement").

tity,[95] aids in mitigating the psychological impacts of urban life,[96] and enhances property values.[97]

Ultimately, evidence that urban forest planning—and the urban forest ecosystem analysis, in particular—is influencing community identity and self expression is shown in those communities undertaking the task, two of which are presented below. Although community well-being underlies a local government's choice to promote urban forests, diversity among the approaches to tree planting, maintenance, and protection illustrates how these decisions are quite local. Urban forests are designed, and individual trees are planted, to fulfill particular goals that are deemed relevant and valued in a particular community.

A. Economic Value in Vancouver, Washington

The urban forest plan in Vancouver, Washington, recognizes the enduring impact of good forest practices that "will be measured over the long term—not just years or decades, but centuries. Vancouver's trees will indeed keep our population healthy and our economy strong."[98] In the mid-nineteenth century, the city of Vancouver enjoyed a "rich and diverse landscape" featuring dense conifer forests, oak woodlands, and prairie lands, much of which was converted in the urbanization of the city.[99] However, rapid growth during and after World War II, combined with a significant storm event in 1962, hobbled the city's resources and drove its residents to collaborative action. Today's urban forest vision

---

95. CITY OF SONOMA, CAL. MUN. CODE § 12.08.010 (1975) ("[T]rees in the community and in the neighborhood provide a sense of identity and tradition and enhance property values."); CITY OF MYRTLE BEACH, S.C., MUN. CODE § 903.1 (2006) ("to create special places that are inviting; to create a civic identity").

96. CITY OF VENETA, OR., MUN. CODE § 8.10.010(2) (1999) (Trees provide "natural beauty and contrast to the built environment which contributes to the physical and mental well-being of residents."); CITY OF KNOXVILLE, TENN., CITY ORDINANCE §14-27 (2011) ("The purpose and intent of this article is to encourage the preservation and protection of trees within the city because of the unique benefits they provide the community in . . . providing citizens with psychological relief from the increasing complexities of the manmade urban environment."); CITY OF ISSAQUAH, WIS., MUN. CODE § 18.12.010.C.2 (1979) ("Provide visual relief from large expanses of parking areas and reduction of perceived building scale").

97. CITY OF ISSAQUAH, WIS., MUN. CODE §18.12.010.C.6 ("Maintain and protect property values and enhance the general appearance of Issaquah").

98. STEVE DUH, CONSERVATION TECHNIX, INC., CITY OF VANCOUVER URBAN FORESTRY MANAGEMENT PLAN 3, 3 (2007), *available at* http://www.mrsc.org/govdocs/V35urbforestplan.pdf.

99. *Id.* at 1.

acknowledges that Vancouver's green infrastructure "accrues value and provides greater services as time passes."[100]

To capture the economic benefit of urban trees, Vancouver adopted a comprehensive regulatory scheme to protect its trees or otherwise maintain the current level of forest ecosystem services (and, if possible, to increase the level of services). The city regulates tree removal on both private and public property based on the type and size of the particular tree, requires developers to provide tree removal, planting, and maintenance plans with their applications, and integrates its tree-protection policies throughout its development regulations. Hence, tree protection standards appear in regulations governing erosion control[101] and stormwater management,[102] grading and excavation, and the protection of critical and ecologically sensitive areas.[103] Vancouver estimates that its existing urban forest, which provides stormwater control and air pollutant removal services,[104] energy (cooling) cost savings, and improved aesthetics and property values,[105] has proven to be a sound investment. Vancouver estimates an annual net benefit per tree of $1–8 for small trees, $19–25 for medium-sized trees, and $48–53 for large trees.[106]

B. Public Appearance in San Francisco, California

In contrast, San Francisco, California, demonstrates that an abstract expression of value in trees has little meaning until the ecosystem services analysis helps design an urban forestry implementation scheme that is adapted to local ecologies. Hence, San Francisco, premised its urban forest plan in part on the community's association with urban trees:

> San Franciscans value the City's forest. Most residents are satisfied with the park system and value its presence. A majority are satisfied with the trees on the street where they live. One in four has planted a tree! A majority of San Franciscans want

100. *Id.* at 7.

101. VANCOUVER, WASH., MUN. CODE § 14.24.020 (2009).

102. VANCOUVER, WASH., MUN. CODE § 14.25.200 (2009).

103. VANCOUVER, WASH., MUN. CODE §§ 20.740.010, 20.740.030 (2005).

104. STEVE DUH, *supra* note 98, at 7–8. Vancouver adopts estimates made by American Forests in a 2001 review of the city's urban forest ecosystem. *Id.* at 7.

105. *Id.* at 9 ("Well-maintained trees improve residential 'curb appeal' and increase potential buyers' willingness to pay a three to seven percent premium for property. Trees in retail settings increase shoppers' willingness to pay for goods and services by twelve percent. Shoppers also indicate that they are willing to drive farther and stay longer if a retail district is well-landscaped with trees.").

106. *Id.*

> City government to take a leadership role in managing the urban forest.[107]

Despite this reported sense of satisfaction, the primary driver for San Francisco's urban forestry is developing a sense of place in public spaces. Tree canopy covers only 12 percent of the city[108] (compared to a national average canopy cover of 27.1 percent, and 19.7 percent in Vancouver, Washington).[109] San Francisco attributes its low coverage to unfinished tree planting projects and the age of its standing trees.[110] Others explain the low canopy cover percentage by reference to the city's history. As one local environmentalist noted, San Francisco "was sand dunes. We're creating an urban forest. It's not like we lost it—we never had it."[111] Regardless of the origin, what concerns San Francisco now is the city's commitment to protect its "urban forest."[112] Significantly increasing the canopy coverage of the city's urban forest is admittedly not possible without private involvement, as many urban trees grow on private land.[113] Yet, although the city has convened an Urban Forestry Council, budgeted for tree plantings and maintenance on public property, and even identified trees on private property that are subject to regulation, the city's laws do not apply generally to the treatment of trees on private property.[114]

As Vancouver and San Francisco illustrate, wide variations exist when it comes to local tree protection programs, but this discrepancy

---

107. S.F. URBAN FORESTRY COUNCIL, *supra* note 6, at 17.

108. *Id.* at 9. Nevertheless, in San Francisco's urban forest, "over 287 tons of ozone, particulates, nitrous oxides, sulfur dioxide and carbon monoxide are taken out of the air by the urban forest. The value of this environmental benefit is $1.3 million per year. In addition, San Francisco's trees remove 5,100 tons of carbon from the atmosphere and store approximately 194,000 tons as biomass" (emphasis omitted). *Id.* at 10.

109. STEVE DUH, *supra* note 98, at 5.

110. S.F. URBAN FORESTRY COUNCIL, *supra* note 6, at 6.

111. Patricia Yollin, *Group Brings City Under the Canopy*, SFGATE.COM, Nov. 19, 2006, http://articles.sfgate.com/2006-11-19/bay-area/17322020_1_urban-forest-tree-plantings/2 (quoting Isabel Wade, Exec. Dir. of the Neighborhood Parks Council).

112. This term is defined to include trees in rights-of-way or other public property, landmark trees, and "significant trees," which include trees that lie at least partially within 10 feet of a public right-of-way and meet certain size requirements. S.F. PUB. WORKS CODE, Art. 16, §§ 802, 810A (1996), *available at* http://www.amlegal.com/nxt/gateway.dll/California/publicworks/publicworkscode?f=templates$fn=default.htm$3.0$vid=amlegal:sanfrancisco_ca$sync=1.

113. *See* James R. Clark et al., *A Model of Urban Forest Sustainability*, 23 J. ARBORICULTURE 17, 21 (1997) (stating that local governments typically confront this issue, as the majority of trees in urban forests grow on private lands).

114. S.F. PUB. WORKS CODE, *supra* note 112, at § 802 (explaining that the definitions section of the Public Works Code distinguishes between public and private property and states that the code only applies to public trees).

also suggests that the urban forest means something different to different communities. Through an ecosystem services analysis, local governments can better understand the relevance of urban forests to local economies, social welfare, and environmental health. Yet comparing different local approaches to urban forestry also suggests that the urban forest is not being understood in the abstract, either as an inherent value or as a mandate. The urban forest presents different opportunities based on local contexts and ecosystem needs, and the ecosystem service analysis helps local governments determine how the urban forest can serve as a local asset. As illustrated above, local ecosystem value is derived from the functions that trees serve in a particular community.

C. Urban Environmental Justice and Urban Forests

Another difficult dilemma in urban forestry relates to the equitable distribution of ecosystem benefits. Municipal tree programs have been viewed skeptically for their impacts on race, gender, and economic status,[115] a skepticism that seems well-supported by the distribution of urban forest resources among different neighborhoods.[116] However, the appropriate conclusions about the distributional impacts of urban forest programs may be derivative of scale. On one hand, the benefits and enjoyment of urban forests are more accessible, and therefore, more inclusive than wilderness areas; the accessibility of forests in urban areas serves as a distributional tool to insure that urban populations may benefit from the interactional services offered by trees. Yet within urban areas and among neighborhoods, whether based on trees per acre or per capita, canopy cover and tree plantings (and as a result, tree maintenance expenditures) appear to historically favor affluent over low-income areas as a consequence of available space as well as public and private planning priorities.[117]

In a sense, the distributional justice question illustrates that the urban forest can be manipulated to achieve particular social goals that relate to the services provided by trees. That is, the "naturalness" of trees does not prevent urban foresters from accomplishing distributional goals in the urban forest context, and, as such, may be less problematic than forming a strategy to resolve historical social inequities, such as patterns

115. *See generally* Braverman, *supra* note 81; Harold A. Perkins et al., *Inequitable Access to Urban Reforestation: The Impact of Urban Political Economy on Housing Tenure and Urban Forests*, 21 CITIES 291, 292 (2004).

116. *See, e.g.*, STEVE DUH, *supra* note 98, at 3.

117. *See* Kollin & Schwab, *supra* note 3, at 9 ("[E]fforts to cut costs for subsidized housing by eliminating trees and landscaping may exacerbate the social ills of disadvantaged urban communities, resulting in greater overall costs.").

of residential segregation. On the other hand, the urban forest presents distributional opportunities to resolve these historical patterns, although tree planting opportunities may be limited by existing pavement, built setback areas, private property boundaries, and other challenges for local governments in implementing tree canopy goals.[118] In either event, addressing this social problem will require valuing and prioritizing among the services offered by urban forests.

As has been observed, "[t]rade-offs among ecosystem services increase the likelihood of sociopolitical debates because different groups are likely to place different relative values on different services."[119] As with all urban infrastructure, the purposes served by urban forests will be largely determined by local needs. The question here relates to how different neighborhoods perceive of, and can benefit from, the services of urban forests. In some areas, communities may desire greener surroundings but may be unable to maximize the ecological, social, or economic benefits of trees due to past practices of privatization, shrinking availability of planting space, or local uses for trees. In these areas, vacant properties, public open spaces, and street tree plantings will exhaust planting opportunities. In others, demolition of deteriorated structures and concrete removal will provide opportunities to add forest services to historically underserved neighborhoods. Yet, because urban forests can be designed to benefit urban areas under the guidance of an ecosystem services analysis, local governments employing this analysis will be able to link the benefits of planning the urban forest to the areas of a community where such services are needed.

V. CONCLUSION

Urban forests provide the benefits of a natural, cost-effective green infrastructure. In urban areas, trees "soothe eyes and spirits, they shade, they form special places for recreation or relaxation, they provide habitat for birds and other wildlife, they purify the air, and they increase the market value of real estate."[120] In light of evidence that the economic benefits of maintaining functional urban ecosystems exceed management

118. *See generally,* Alexandra Dapolito Dunn, *Siting Green Infrastructure: Legal and Policy Solutions to Alleviate Urban Poverty and Promote Healthy Communities*, 37 ENVTL. AFF. 41 (2010).

119. WATER SCI. & TECH. BD., *supra* note 79, at 181.

120. Lawrence, *supra* note 5, at 35 (attributing the meaning of urban trees to the intentions of landscaping in the seventeenth and eighteenth centuries).

costs,[121] urban forest initiatives are productive public investments. In addition, because urban forests share space with the vast majority of the human population,[122] they have the potential to impose substantial costs or advantages, depending on how they are designed and managed.

The fascinating aspect of urban forestry is the recognition that although urban trees and forests consistently provide these services through natural processes, the very existence of the urban forest is both a conceptual and a physical construct. Acknowledging this fundamental contingency in the value of urban forests may raise complex questions about identifying the "natural" and about the needs of human experiences in nature. In the meantime, understanding the nature of urban forests as urban, contingent, and constructed empowers local governments to become ecosystem beneficiaries by bringing nature into their communities.

121. McPherson, *supra* note 11, at 48 ("Average annual benefits from the selected environmental services are projected to exceed costs by $15.48 per tree (2.6 benefit-cost ratio)." This figure is before discounting adjustments are made).

122. DWYER ET AL., *supra* note 15, at 3. *See also* Nowak et al., *supra* note 15.