URBAN FOREST STRUCTURE, BENEFITS, AND VALUE

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ABSTRACT: Assessments of urban forests in the United States reveal that there are currently 3.8 billion trees in urban areas with a compensatory value of $2.4 trillion.

Introduction

The first national urban forest assessment recently was completed as part of the Renewable Resources Planning Act (RPA) process (Dwyer et al. 2000; Nowak et al. 2001a). This assessment used 1991 Advanced Very High Resolution Radiometer data (Zhu 1994) in conjunction with field (Nowak and Crane, 2000) and census data to estimate that urban areas in the lower 48 states:

- *Cover 3.5 percent of the land area*
- *Have doubled in size between 1969 and 1994*
- *Contain more than 75 percent of the U.S. population*
- *Average 27.1 percent tree canopy cover*
- *Contain approximately 3.8 billion trees*

As part of the current RPA national urban forest assessment update, new (2000-2001) higher-resolution Landsat data are being used to update urban tree cover estimates and assess rates of change over time. In addition, studies are examining urban forest functions and exploring U.S. urban forest resource values. This paper summarizes some of the most recent findings concerning the compensatory and functional values of urban forests.

Compensatory and Functional Values

Compensatory value is based on replacement cost and is related to compensation that would be made to owners for the loss of a tree. Using the tree-valuation formula of the Council of Tree and Landscape Appraisers (1992) (CTLA formula), compensatory values estimate the cost to replace a tree with one of the same species, size, and condition in the same location. Compensatory value can be viewed as an estimate of the value of the urban forest structure as an asset. Urban forests also can be valued on the basis of functions that they perform (e.g., esthetics, pollution removal, temperature modification).

For an example of these two different types of tree value (compensatory and functional), consider a factory that produces widgets with a net profit of $100,000 per year. The value of the physical structure of the factory (e.g., $1 million) is based on the cost to rebuild or replace the factory with a similar structure. This value is what the factory owner is likely to claim if the factory is lost. The factory can also be valued based on the potential profits. The value of the factory structure ($1 million) is comparable to the compensatory value of the forest. The net profit ($100,000/yr) is analogous to the functional value of the forest. Compensatory value is based on the structure as an asset in place, and functional value is an annual value based on the functions of the particular structure.

The compensatory or structural value of the urban forest considers the forest as an asset at one point in time and provides an estimate of the loss that would be incurred by the owner if that asset were lost. The compensatory value of a tree is likely to be similar to its contribution to real estate value. Values generated by the CTLA formula and by real estate appraisals are routinely used in litigation involving the loss of trees. Morales et al. (1983) compared contribution to real estate values and results of the CTLA formula and found them to be closely correlated. Similar studies are needed to improve the CTLA formula and develop better estimates of the values of trees as a structural asset.

Compensatory values can be used to estimate the amount of compensation required when urban trees are lost. Functional values can be used to guide urban forestry policies and programs. To the extent that compensatory values reflect contributions to real estate, they can be used to estimate the asset value of the urban forest and its contribution to the generation of tax revenues.

Although trees typically have positive functional values (similar to factory profits), trees can have negative functional values (similar to monetary losses in factories) when the wrong tree is put in the wrong site (e.g., trees can increase annual building energy use in certain locations). Urban forest management is needed to enhance the functional values of the urban forest and thereby improve human health and well-being, and environmental quality in cities.

Compensatory (or Structural) Value of the U.S. Urban Forest Resource

Based on the CTLA formula and field data from eight cities, total compensatory value of entire city tree populations ranges from $101 million in Jersey City, New Jersey to $5.2 billion in New York, New York. When expanded to the 48 adjacent states based on national urban tree-cover data, total urban forest compensatory value is estimated at $2.4 trillion[1].

Recent infestations of an Asian longhorned beetle, Anoplophora glabripennis, have led to the removal of thousands of infested urban trees in New York City and Chicago in an effort to eradicate this exotic insect in the United States. Compensatory value of potential loss due to an infestation by this beetle for various U.S. cities ranges from $72 million (Jersey City) to $2.3 billion (New York). The corresponding canopy cover loss, which would occur if all preferred host trees were killed, ranges from 13 percent (Oakland, California) to 68 percent (Jersey City). The estimated maximum potential urban impact of Anoplophora glabripennis across the 48 adjacent states is a loss of 34.9 percent of total canopy cover, 30.3 percent tree mortality (1.2 billion trees) and value loss of $669 billion (Nowak et al. 2001b).

Functional Value of Carbon Storage and Sequestration by U.S. Urban Forests

To determine the functional values of urban forests, research is needed on how urban forest structure affects functions (e.g., how differing amounts and types of trees impact air pollution) and the value that society places on these functions. Research to quantify some of the functional benefits and values of urban forests has begun (e.g., air pollution removal, carbon storage, energy conservation), but other urban forest functional values have yet to be quantified (e.g., esthetic values, individual and community values, wildlife values).

Based on field data from 10 U.S. cities, national urban tree-cover data, and an estimated marginal social cost of carbon dioxide emissions of $20.3/tC (Fankhauser, 1994), it is estimated that urban trees in the lower 48 states currently store 700 million metric tons of carbon ($14,300 million value) with a gross carbon sequestration rate of 22.8 million tC/yr ($460 million/yr) (Nowak and Crane, in press).

Conclusion

Urban forests in the United States are a valuable resource that affect the majority of Americans and significantly affect human health and environmental quality in and around urban areas. Researchers continue to investigate the structure and value of this important resource and how its contribution to social well-being is changing. This information will help guide policies and programs for sustaining the urban forest.

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Footnotes:
[1]Nowak, D.J.; Crane, D.E. Manuscript in review. Compensatory value of urban trees in the United States. To be submitted to Journal of Arboriculture.

References:

Council of Tree and Landscape Appraisers. 1992. Guide for plant appraisal. Savoy, IL: International Society of Arboriculture.

Dwyer, J.F.; Nowak, D.J.; Noble, M.H.; 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: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Fankhauser, S. 1994. The social costs of greenhouse gas emissions: an expected value approach. The Energy Journal. 15(2): 157-184.

Morales, D.J.; Micha, R.R.; Weber, R.L. 1983. Two methods of valuating trees on residential sites. Journal of Arboriculture. 9(1): 21-24.

Nowak, D.J.; Crane, D.E. 2000. The urban forest effects (UFORE) model: quantifying urban forest structure and functions. In, Hansen M.; Burk, T. eds. Proceedings: Integrated tools for natural resources inventories in the 21st century; IUFRO Conference; 1998 August 16-20; Boise, ID. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. pp. 714-720.

Nowak, D.J.; Crane, D.E. [In press] Carbon storage and sequestration by urban trees in the United States. Environmental Pollution.

Nowak, D.J.; Noble, M.H.; Sisinni, S.M.; Dwyer, J.F. 2001a. Assessing the U.S. urban forest resource. Journal of Forestry. 99(3): 37-42.

Nowak, D.J.; Pasek, J.; Sequeira, R.; Crane, D.E.; Mastro, V. 2001b. Potential effect of Anoplophora glabripennis (Coleoptera: Cerambycidae) on urban trees in the United States. Journal of Economic Entomology. 94(1): 16-22.

Zhu, Z. 1994. Forest density mapping in the lower 48 states: a regression procedure. Res. Pap. SO-280. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station Research Paper.

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