Executive Summary

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Air Quality Effects of Urban Trees and Parks

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Executive Summary

Estimated Value of Trees in U.S. Urban Parks

- Structural value = $300 billion
- Air temperature reduction = unknown, but likely in the billions of dollars per year
- Air pollution removal = $500 million per year
- Reduced ultraviolet radiation = unknown, but likely substantial
- Carbon storage (trees): $1.6 billion
- Annual carbon removal (trees): $50 million per year

Estimated Value of Trees in Parks in Chicago, Illinois

- Structural value = $192 million
- Air temperature reduction = unknown
- Air pollution removal = $344,000 per year
- Reduced ultraviolet radiation = unknown
- Carbon storage (trees): $1.1 million
- Annual carbon removal (trees): $32,800 per year

Parks are significant parts of the urban landscape and comprise about 6% of city and town areas in the conterminous United States. These urban parks are estimated to contain about 370 million trees with a structural value of approximately $300 billion. The number of park trees varies by region of the country, but they can produce significant air quality effects at the local scale, both within and near parks, related to air temperatures, air pollution, ultraviolet radiation, and carbon dioxide (a dominant greenhouse gas related to global climate change). Additional open space and other vacant lands in cities, which may contain parklands, contribute significant additional benefits. Effects of parks and open space at the city scale can vary significantly depending on the amount of parkland and amount of tree cover within the parkland.

Air Temperature Reduction

Parks generally have lower air temperatures than surrounding areas. Temperatures are usually cooler toward the center of a park than around its edges. At night, the center of a large park may be 13°F (7°C) cooler than surrounding city areas.

The cooler air from parks often moves out into adjacent developed neighborhoods and cools air there. This cooling of surrounding areas tends to increase with park size and percentage of the park covered by trees.

Most studies show that temperature reductions by parks are greater at night than during the day. On clear nights with low wind speed, park lawn areas may be cooler than areas under trees. Thus, parks that include a variety of site conditions, areas with trees close together as well as open lawns, will maximize the options for comfort of visitors.

Cooler air temperatures provided by urban parks can have significant impacts on human health. During heat wave events, which can kill hundreds of people, park areas may provide city dwellers with some respite from high air temperatures, particularly in the evening. During hot, sunny days tree shade can greatly increase human comfort.

Because park influences on air temperature extend to developed areas outside of parks, local energy use for heating and cooling buildings is also affected. Although the net annual effect of parks on energy costs by reducing temperatures is difficult to estimate, at least in the southern United States, the effect will usually be a net annual benefit. Furthermore, large park trees will reduce winds and may provide a benefit for winter heating of buildings near the park.

Although the overall economic effect of urban trees and parks on air temperature reduction is not fully known, it is likely on the order of billions of dollars annually at the national scale in terms of improved environmental quality and human health.

Air Pollution Reduction

Trees and vegetation in parks can help reduce air pollution both by directly removing pollutants and by reducing air temperatures and building energy use in and near parks. These tree effects can reduce pollutant emissions and formation. However, park vegetation can increase some pollutants by either directly emitting volatile organic compounds that can contribute to ozone and carbon monoxide formation or indirectly by the emission of air pollutants through vegetation maintenance practices such as operation of chain saws and use of transportation fuels.

Annual pollution removal and economic benefits by U.S. urban park trees is estimated at about:

- 75,000 tons ($500 million) or
- 80 pounds per acre of tree cover ($300 per acre of tree cover)

Ultraviolet Radiation Reduction

Park trees can shield people from ultraviolet (UV) radiation, as tree leaves absorb about 95% of UV radiation. The reduction in UV exposure to park visitors is important because excess exposure to UV is the cause or contributing factor for three types of skin cancer, and UV radiation is also blamed for contributing to cataracts of the eye.

While the overall economic effect of reduced UV exposure to park visitors is unknown, it is likely substantial. In 2004, the total direct cost associated with the treatment for the most common skin cancers, non-melanoma skin cancer, was $1.5 billion. The total expense for cataract operations is also great, because this is the most common surgery in the United States.

Carbon Dioxide (Climate Change) Reduction

Trees and vegetation in parks can help reduce carbon dioxide (a dominant greenhouse gas) by directly removing and storing carbon dioxide and indirectly by reducing air temperature and building energy use in and near parks. Park vegetation can increase carbon dioxide by either directly emitting carbon dioxide from the vegetation (e.g., decomposition) or indirectly through emissions from vegetation maintenance practices.

Carbon storage and annual removal by urban park trees and soils in the United States is estimated at about:

- Carbon storage (trees): 75 million tons ($1.6 billion)
- Carbon storage (soils): 102 million tons of carbon ($2.1 billion)
- Annual carbon removal (trees): 2.4 million tons ($50 million)

On a per acre basis, carbon effects for U.S. parks are estimated to be:

- Carbon storage (per acre of tree cover): 40 tons ($800)
- Carbon storage (per acre of soil): 32 tons ($650)
- Annual carbon removal (per acre of tree cover): 1.2 tons ($25)

Recommendations and Goals for Park Management

- Consider that most of the effects of trees on microclimate and air quality are beneficial for park users and nearby residents.
- Park designs that include a variety of land cover—areas of dense trees, scattered trees, and lawn—are likely to provide the greatest opportunities for optimum physical comfort of visitors.
- Increase the number of healthy trees (increases pollution removal and carbon storage).
- Sustain existing tree cover (maintains pollution removal levels and carbon storage).
- Maximize use of low volatile organic compound (VOC) emitting trees (reduces ozone and carbon monoxide formation).
- Sustain large, healthy trees (large trees have greatest per tree effects on pollution and carbon removal).
- Use long-lived trees (reduces long-term pollutant emissions from planting and removal).
- Use low maintenance trees (reduces pollutants and carbon emissions from maintenance activities).
- Reduce fossil fuel use in maintaining vegetation (reduces pollutant and carbon emissions).
- Plant trees in energy conserving locations (reduces pollutant emissions from power plants).
- Plant trees to shade parked cars (reduces vehicular VOC emissions).
- Supply ample water to vegetation (enhances pollution removal and temperature reduction).
- Avoid pollutant sensitive species in heavily polluted areas (increases tree health).
- Utilize evergreen trees for particulate matter reduction (year-round removal of particles).
- Where feasible, provide park recreation areas with large trees to give visitors the option of being in shade.
- Consider posting for park visitors up-to-date recommendations from health authorities on avoiding excessive exposure to UV radiation. Usually these recommendations include seeking shade around midday.
- Utilize wood from removed trees for energy or in long-term products. (This reduces the need for fossil-based energy or reduces or delays carbon emissions.)

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BIOGRAPHICAL PROFILE

David J. Nowak
Project Leader
United States Department of Agriculture – Forest Service

David J. Nowak is a Project Leader with the USDA Forest Service, Northern Research Station in Syracuse, NY. Dr. Nowak received a B.S. and M.S. from SUNY College of Environmental Science and Forestry, and a Ph.D. from the University of California, Berkeley. He has authored over 190 publications and is a recipient of the National Arbor Day Foundation's highest honor - the J. Sterling Morton Award, which recognizes lifelong commitment to tree planting and conservation at a national or international level, American Forests' Urban Forest Medal recognizing outstanding national contributions in urban forest research, the Distinguished Science Award of the Northeastern Research Station, the Forest Service Chief's Honor Award for Engaging Urban America, New York State Arborists-ISA Chapter Research Award, and was a contributing member of the 2007 Nobel Peace Prize winning Inter-governmental Panel on Climate Change. His research investigates urban forest structure, health, and change, and its effect on air quality and greenhouse gases. He also leads teams developing software tools to quantify ecosystem services from urban vegetation (e.g., UFORE and i-Tree programs).

BIOGRAPHICAL PROFILE

Gordon M. Heisler
Meteorologist
United States Department of Agriculture – Forest Service

Dr. Gordon Heisler became interested in micrometeorology while studying what happens to snow landing on conifer forests for his Ph.D. thesis at the State University of New York College of Forestry in Syracuse in the late 1960's. After that Syracuse stint, he spent 2 years at a science resource center near Hartford, CT, where he taught ecology and meteorology to grades 1 to 12 and meteorology at the University of Hartford. Since 1972 he has been a research meteorologist with the U.S. Forest Service in New Jersey, Pennsylvania, and for 19 years in Syracuse, NY, the entire time collaborating in studies of environmental impacts of forests with researchers from universities including SUNY in Syracuse, Purdue, Princeton, Penn State, Rutgers, University of Connecticut, and Southern University in Baton Rouge. In 2005, SPIE—The International Society for Optical Engineering, presented Dr. Heisler with an award for "a career of excellence in pioneering studies on the effects of urban forests on UV radiation." He has been involved with the Baltimore Ecosystem Study, a Long Term Ecological Research program, for the last 13 years. He is active in the American Meteorological Society and the International Association for Urban Climate.

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