

# URBAN FORESTRY RESEARCH: THE FOREST SERVICE PERSPECTIVE

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**Abstract.** In 1991, the International Society of Arboriculture (ISA) conducted a National Assessment of research needs and priorities in urban forestry. Using the findings of this Assessment, the USDA Forest Service is planning and implementing its research program to meet the needs identified by the ISA effort. Due to the comprehensive nature of the ISA research needs list, it will be several years before all needs can be addressed by public and private urban forestry research entities. Therefore, the USDA Forest Service has focused on selected needs that the agency can address within its current funding and staffing constraints. In addition to direct research, the USDA Forest Service is also involved in supportive and cooperative efforts including: the ISA Research Trust, American Forests, and several other urban forestry oriented institutions.

As a reference point, urban forests include forested and vegetated open-space areas along a broad range of locations. These locations range from city centers extending out to areas now considered on the wildland-urban interface. Typically, wildland-urban interface areas are thought of as involving wildland locations that are within a one-hour drive from a metropolitan center. Using these parameters, the urban forests occupy a significant portion of the landscape. It has been estimated that urban forests in the United States include close to 70 million acres (17). This represents a total area which is over one-third the size of the entire National Forest System.

Total economic value for urban forests is estimated at 50 billion dollars. Street trees alone account for 30 billion dollars of value (16). In just considering economic value, urban forests justify an important area of research. This is particularly true when one considers that the average life span of the urban forest tree is only 32 years (16).

## Benefits of the Urban Forests

Urban forests provide a wide range of benefits including beauty and aesthetics, temperature

moderation and energy savings, air quality enhancement, and increased real estate values (4). In brief, urban forests improve the overall quality of life for urban dwellers. To date, a number of research findings have been produced that identify and help quantify these benefits.

**Beauty and aesthetics.** Research has generally been consistent in finding that people prefer vegetated areas over non-vegetated sites (5,7,9). In addition, this vegetation preference was especially true for the presence of trees (20). In a related work (11), it was found that the urban forest was valued as a mechanism to characterize, differentiate and beautify space. Trees and the urban forest tend to play a role in creating a distinctive and landmark character within a specific location (11). In a sense, the urban forest assumes a symbolic function for communities by providing a sense of beauty and defining values.

**Temperature moderation and energy savings.** The urban forest can provide a buffering effect for both temperature and pollution effects. The urban forest environment affects both surface and ambient air temperature through three mechanisms: direct effects of shading, evapotranspiration and wind reduction (1). Outdoor temperature modification can reduce the energy resources needed to cool or heat buildings—both industrial or residential buildings, but especially residences. A number of research efforts now suggest that trees and other vegetation can be effective in lowering outdoor temperatures in summer, and in reducing heat loss in winter by reducing wind flow (1,8). Urban forests, through temperature modification, can reduce fossil fuel use in energy generation facilities that would otherwise be needed for higher cooling and heating demands.

**Air quality enhancement.** Urban forests can act as pollution filters and “sinks” by trapping air pollutants such as oxides of sulfur and nitrogen and tropospheric ozone (2). In the case of airborne particulates, the urban forest, particularly through its canopy, can collect undesirable particulates which are eventually washed off by rain and deposited on the soil surface.

Of growing concern is the increasing levels of CO<sub>2</sub> in the atmosphere with its accompanying “greenhouse” effect. In a recent work (16), it has been estimated that urban forests provide an annual net storage of 6.5 million tons of CO<sub>2</sub>, with a total of 800 million tons of carbon estimated to be sequestered in urban forests.

**Enhancement of real estate values.** Urban trees and vegetation greatly enhance real estate values. It has been estimated that residential property values in the United States have an additional added value of at least \$1.5 billion annually due to the trees and vegetation located on these properties (5). This estimate does not include value that could be added for nearby public parks, greenways, and forests.

**Quality of life.** Urban trees and forest lands can enhance the quality of life by providing restorative environments for reducing the mental fatigue of the urban resident (13,14). Past research has demonstrated that the urban forest environment can enhance recovery from medical surgery (21), facilitate relaxation and catharsis (19) and encourage a sense of serenity and joy (18). Results of research in Charleston, South Carolina, after Hurricane Hugo, showed that residents were acutely aware of the intangible benefits of urban trees, with numerous respondents to a survey indicating that trees provided relaxed and positive feelings (11).

In a USDA Forest Service study in 10 Ohio towns, trees were found to be the single most important feature contributing to visual quality in an evaluation of residential street aesthetics (19). In addition, urban trees can act as symbols of people or events, religious beliefs and a sense of history (5).

### **Demographic Trends Influencing Urban Forestry**

**Planning and implementation.** There can be little doubt that cities and the urbanized environment play an increasingly important role in the lives of millions of Americans. The U. S. has urbanized to the point that it is becoming a moot issue whether one lives in a city or other urban environment; the vast majority do. According to the 1990 Census Report of the United States, approximately 73 percent of U. S. residences are located in urban areas, with the remaining 27 percent in rural areas. However, 93 percent of the rural residences are non-farm, leaving but 7 percent of the U. S. residences in rural farm areas (10).

In California, demographics are important to the USDA Forest Service due to the large, and growing, population centers located near several National Forests, which are now considered to be urban forests. Recently compiled data from the 1990 U. S. Census of Population shows that the ethnic and racial population mix in California is much different from that of the United States composite, Table 1. To better serve California users of the National Forests near major California urban areas, we must first be aware of the different population characteristics.

From a natural resource management perspective, the urban forest plays an increasingly important role in society, particularly when one considers that the urban landscape is where most of the people live. Moreover, the urban resident is also a voting resident, and increasingly demanding of a role in the management of our natural resources (3). Efficient and cost-effective management of these urban forest resources will be contingent on a research program that is comprehensive enough to include the many aspects of urban forestry and focused enough to provide the in-depth level of information that managers need to make sound decisions. The purpose of this paper is to describe the USDA Forest Service urban forestry research program in terms of its multi-dimensional characteristics and future initiatives.

### **The ISA Research Summit Report**

The USDA Forest Service urban forestry research program is based on the priorities estab-

**Table 1. Resident population by race and hispanic origin for the United States, Pacific States, and California, 1990.**

Region/ State	Number (1000)	Percent distribution *				
		White	Black	Am. Indian, Eskimo, Aleut	Asian Pacific	Hispanic origin**
U. S.	248,710	80	12	1	3	9
Pacific States	39,127	72	6	1	10	21
California	29,760	69	7	1	9	26

\* Total percent distribution does not add to 100 percent.

\*\* Persons of Hispanic origin may be of any race.

Source: U. S. Bureau of the Census (23).

lished in the report: A National Research Agenda For Urban Forestry In The 1990's (12). This report was based on a national assessment of urban forestry research needs that was accomplished under a cooperative agreement between the International Society of Arboriculture (ISA) and the USDA Forest Service in 1991. The development of the research needs assessment involved more than 120 urban forestry professionals and 30 organizations. The report covered both research needs, and the technology transfer needs that would follow the completion of the research. This paper will be limited to a discussion of the research needs and the USDA Forest Service research program.

The ISA report identified three priority levels of research needs, covering a range of both basic and applied problems. The needs are listed below in order of priority:

**Highest priority need**

Ecological benefits of the urban forest

**High priority needs**

Economic benefits of the urban forest

Urban tree genetics

Investigation of matching planting site to plant type

Cost-benefits of existing trees versus new plantings

Impact on energy consumption

**Priority needs**

New tree care equipment, techniques, and

practices

Integrated pest management

Construction and its effect on tree health

Basic tree biology

Resource inventory of the urban forest

The role of the urban forest in the urban ecosystem

Community involvement with tree concerns (12)

The USDA Forest Service urban forestry research program is currently involved in several of these priority areas including: Ecological Benefits of the Urban Forest, Economic Benefits of the Urban Forest, Urban Tree Genetics, Impact on Energy Consumption, and Community Involvement with Tree Concerns. Specific research by Research Work Unit (RWU) location is contained in the following section.

**The Forest Service Research Program**

The USDA Forest Service urban forestry research program is conducted under authorization provided in the Forest And Rangeland Renewable Resources Research Act of 1978. Section 3. (a) of this Act contains the research authorization language which guides USDA Forest Service research. This section provides authorization to: "... conduct, support .. demonstrate, and disseminate scientific information about protecting, managing, and utilizing forest and rangeland renew-

able resources in rural, suburban, and urban areas”(24).

Urban forestry research has been conducted by the USDA Forest Service for approximately 15 years. The annual appropriated funding for this research has been relatively modest, averaging roughly \$1,500,000 annually in recent years. USDA Forest Service research in urban forestry is often conducted in conjunction with related recreation research work units—especially those units with missions related to recreation research in high use areas. Therefore, it is difficult to provide more than a general estimate of the scientific effort in urban forestry research in any given year. As in most other USDA Forest Service research, the urban forestry research effort is “leveraged” by numerous cooperative efforts with universities and other organizations such as the ISA Research Trust. For example, approximately \$50,000 was recently provided by the USDA Forest Service to the ISA Research Trust for urban forestry research.

USDA Forest Service research is organized by research work unit (RWU's). These RWU's usually have regional and/or national missions. Scientists assigned to these RWU's may conduct research at one or more locations, depending on the work to be accomplished. The mission of any one RWU may cover a variety of research problems. The following description of research will be primarily by location, rather than RWU.

**Syracuse, New York.** The urban forestry research work unit headquartered in Syracuse, New York, and administered by the Northeastern Forest Experiment Station, has a national mission. This mission is to protect and improve the structure and function of forest ecosystems in urban and urbanizing areas—including the urban-wildland interface—with the twin objectives of increasing the amounts and diversity of benefits society receives from these forests and reducing the costs of their management.

In addition to scientists stationed at the unit's Syracuse, New York, headquarters, the unit currently has scientists based in Chicago, Illinois, (There is also a permanently assigned RWU located in Chicago that is under the administration of the North Central Forest Experiment Station.)

and at the Pacific Southwest Experiment Station's headquarters in Albany, California, and at The University of California-Davis. Stationing unit scientists in Illinois and California gives geographical balance to the urban forest ecology program and produces better science through inter-action of scientists in different regions.

The unit at Syracuse is located and operated in cooperation with the the State University of New York, College of Environmental Science and Forestry. Principal areas of study and expertise include:

- Translating the basic ecology of urban and urbanizing forests into guidelines for planners and managers.
- Modeling urban forest effects on microclimate and neighborhood mesoclimate to improve human thermal health and conserve energy.
- Quantifying and optimizing landscape design for energy conservation, using vegetation.

**Chicago, Illinois.** The permanent urban forestry RWU located in Chicago has been in operation for 15 years, and is under the administrative jurisdiction of the North Central Forest Experiment Station. This RWU has a mission that includes both research in urban forestry and recreation. Specifically the unit's mission is: “To help managers understand how changes in the management of urban forest environments will affect people's use and enjoyment.” In doing this research, the unit develops information and models relative to people's perceptions, choices, and use of particular urban forest areas—including parks, preserves, and street and river corridors (Figure 1). Particular attention is given to urban minority groups. In cooperation with researchers from universities, public agencies, private groups, and forest managers and planners; North Central Station scientists are currently engaged in activities such as the following:

- Developing guidelines for using trees to improve the perceived quality of parks and street corridors.
- Estimating the amount and kind of use at forest preserves and park sites.
- Examining people's preferences and uses of urban tracts.
- Understanding the recreation preferences,

needs, and barriers of diverse population segments, such as racial and ethnic groups, children and older adults.

- Exploring the meanings and values that forest environments have for those who experience them.
- Developing guidelines for environmental education programs for inner-city children.

As mentioned above, the Syracuse RWU also has scientists located in Chicago. These scientists are nearing completion of a special three year study known as: "The Chicago Urban Forest Climate Project" (CUFCP)(15). The mission of the CUFCP is to develop information that greenspace managers, natural resource planners, public utilities, and urban residents can use to obtain more benefit from their investment in Chicago's urban trees. Results of the three year study will describe the potential of different urban forest policies and management strategies to maximize short and long term environmental benefits.

**Athens, Georgia.** Urban forestry research by the RWU located in Athens, Georgia, under the administration of the Southeastern Forest Experiment Station, has been concentrated on a cooperative venture to develop a national prototype of an inner-city forestry and environmental education facility in a city park in Atlanta, Georgia. The



**Figure 2. USDA Forest Service personnel and volunteers providing environmental instruction to children at the Atlanta Urban Tree House.**

Atlanta Urban Tree House is a physical facility located in Bessie Branham Park, and is now in operation (Figure 2). Objectives of the program are:

- To increase awareness, knowledge, and involvement in forestry, conservation, environmental and natural resource issues and concerns through environmental lessons.
- To create new partnerships between the USDA Forest Service, local governments, inner-city neighborhoods, historically Black Colleges and Universities (HBCUs) and other minority institutions, local school systems, the wood products industry, and others.
- To encourage minorities to choose environmentally related careers.

### Research in California

**Albany-Davis Center.** States in the Western United States share urbanization problems with urgent concerns about:

- Management of urban forests for energy and water conservation.
- Management of urban forests to minimize urban-wildland fire hazards.
- Management of urban forests to improve air



**Figure 1. Bicycle trails, like this one in the Chicago area, are increasingly important to urbanites.**



**Figure 3.** Former residential section of Oakland/Berkeley Hills, California, after the October 20, 1991 fire, the worst urban-wildland interface fire in United States history.

quality.

- Conservation of urban forests under pressures from land development.

Because of these urgent concerns, the Albany-Davis field locations have established working partnerships that have contributed over \$200,000 in the last two years toward the solving of these problems. With the extended drought in California, and the severe impact of the recent Oakland Hills fire, the problem of the fire hazard in the urban-wildland interface area is extremely important (Figure 3). This hazard may be minimized with better vegetative management and technical information. Cooperative research has begun with concerned citizen organizations, electric and water utility entities, the academic community, and others.

**North-Central California.** Urban forestry research is in progress by the Pacific Southwest Forest and Range Experiment Station (PSW) on

the forest genetics of tree roots. This research is directed toward development of trees with root characteristics that would minimize potential damage to sidewalks due to undesirable surface root tendencies. Extensive laboratory and field out-planting research is in progress in cooperation with Solano Community College, Solano County, California (Figures 4 and 5); at the PSW Institute of Forest Genetics Laboratory, Placerville, California; and in cooperation with Alabama A & M University, Normal, Alabama (Figures 6 and 7).

**Southern California.** Urban forestry research in Southern California is concentrated on developing information to better serve the 18 million or more annual visitor's to California's four most southerly national forests: The Angeles, Cleveland, Los Padres, and San Bernardino. Many of these visitors are from the greater Los Angeles area. Data developed from the 1990 Census of Population shows that the composition of Los Angeles County is 57 percent white, 11 percent Afro-American, 11 percent Asian-American, 21 percent other non-white, and less than 1 percent American Indian. Of these racial categories approximately 38 percent were reported to be of hispanic ethnic origin (22). Research is being conducted



**Figure 4.** Experiment at Solano Community College—Solano County, California—testing various root barrier treatments to inhibit shallow tree root development. This experiment is comprised of 101 sycamore trees, spaced 15 feet on center, and grown on site three years prior to determination of results.



**Figure 5.** This bio-barrier treatment at experimental planting site—Salono Community College, Salono County, California—exemplifies root barrier treatments that had been installed as planting hole liners when trees were planted three years previous. The planting holes were 18 inches in diameter and the root barriers were installed to a depth of one foot.

relative to the recreational and forest experience expectations of this diverse racial and ethnic population. In addition, research is being conducted on the use of “high tech” equipment in urban forest areas, relative to minimizing environmental degradation of the resource as well as minimizing conflicts with more traditional forest uses and users.

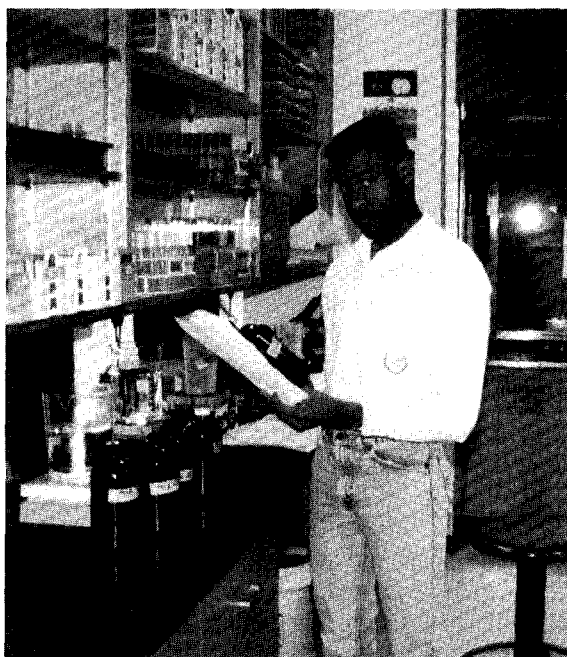
### **Future Research Emphasis**

USDA Forest Service urban forestry research will continue to develop new information of the ecological and economic benefits of the urban forest. The Chicago Urban Forest Climate Project (CUFCP) and related work by the Northeastern Forest Experiment Station headquartered in Syracuse, NY., illustrates work in these priority research areas. The CUFCP is developing a better understanding of the relationships between urban greenspace and hydroclimate, air quality, energy use, and carbon cycling. At the same time, net benefits of urban greenspace are being estimated in dollar terms.

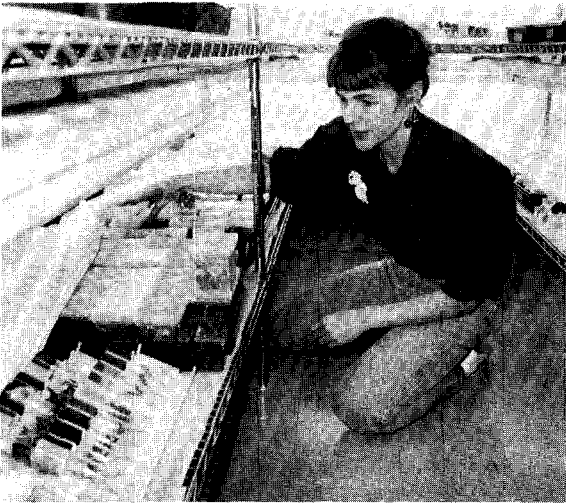
In addition, research in Chicago by the North Central Station RWU will continue to explore the meanings and values of urban forest environments for those who use and experience them. Research will also continue at the North Central and Pacific Southwest Experiment Stations on understanding the recreation preferences, needs and barriers of diverse population segments. And, research will continue on development of guidelines for using trees to improve the perceived quality of parks and street corridors.

In California, research will especially be concerned with the multitude of problems brought about by extensive urban development at the urban/wildland interface. This includes concerns about fire hazard to the population and to the high value property constructed at the urban/wildland interface.

Also, research will be conducted to determine improved techniques for reducing total and peak energy loads through modified or new vegetation distribution that would increase shading and lower temperatures. This research will be conducted



**Figure 6.** Alabama A & M student working on an experiment related to micro-propagation of selected trees that will be field tested for root morphogenesis.



**Figure 7. Mary Beth Eliasson, graduate student at Alabama A & M, evaluating an array of propagules in culture in a room-size micro-propagation chamber. Ms. Eliasson is now employed at a researcher with the USDA Forest Service.**

under the umbrella of a newly signed five year cooperative research agreement with the American Forest's "Cool Communities" program, and within the existing programs at several Forest Service research locations. Integrated with these objectives would be research efforts to utilize species and planting techniques that would improve water conservation—especially for application in California and the Southwestern United States.

Finally, as identified in the ISA research needs report (12), urban tree genetics research will continue on improved selection from existing trees with distinctive traits, and on genetic improvement through molecular biology. There are numerous needs such as for: more drought resistant trees, as well as trees that are more pest resistant, and that are more adaptive to harsh conditions.

It is expected that all of these future research efforts will involve extensive cooperative research efforts with a wide range of institutions including the ISA Research Trust, the academic community, the urban forest industry, and others. Much new information is needed to better serve the rapidly growing urban population of the United States.

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**Résumé.** En 1991, l'International Society of Arboriculture (ISA) menait une étude sur l'Évaluation nationale des besoins en recherches et des priorités en foresterie urbaine. Employant les résultats de cette évaluation, le USDA Forest Service a planifié et implanté son programme de recherche afin de rencontrer les besoins identifiés par l'étude de l'ISA. En raison de la nature détaillée de la liste de l'ISA des besoins en recherche, cela nécessitera plusieurs années avant que tous les besoins soient alloués aux organismes publics et privés de recherche en foresterie urbaine. Le USDA Forest Service s'est concentré sur des besoins précis que l'agence pouvait prendre en charge à même ses contraintes budgétaires et administratives courantes. En plus de la recherche directe, le USDA Forest Service s'est impliqué dans des efforts de support et de coopération auprès du ISA Research Trust, de l'American Forests et de plusieurs autres institutions ou groupements orientés vers la foresterie urbaine.

**Zusammenfassung.** 1991 leitete die International Society of Arboriculture (ISA) ein nationales Gutachten über den Forschungsbedarf und die Prioritäten des städtischen Forstwesens. Unter Berücksichtigung der Ergebnisse dieses Gutachtens plant und verwirklicht der USDA Forest Service sein Forschungsprogramm um diesem Informationsbedarf entgegenzutreten. Aufgrund der umfangreichen Beschaffenheit der ISA-Forschungsbedarfsliste wird es viele Jahre dauern, bis alle öffentlichen und privaten Forschungszehnten für städtisches Forstwesen diesen Anforderungen gerecht werden können. Der USDA Forest Service hat anhand von einigen ausgewählten Anliegen verdeutlicht, daß die Dienststelle im Rahmen ihrer finanziellen und personellen Grenzen diesen Anforderungen nachkommen kann. Neben seinen direkten forschungstätigkeit ist der USDA Forest Service auch an kooperativen Hilfsmaßnahmen beteiligt, die den ISA Research Trust, American Forests und diverse andere Institutionen einschließt, die sich mit städtischen Forstwirtschaft beschäftigen.