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# FUTURE DIRECTIONS FOR URBAN FORESTRY RESEARCH IN THE UNITED STATES

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**Abstract.** Urban forestry research promises to continue to be an integral part of the growth and development of forestry in urban and urbanizing areas of the United States. The future is expected to bring increased emphasis on research in support of the care of trees and other plants, ecological restoration, and comprehensive and adaptive management across the landscape. Particular emphasis will be needed on research to guide improvements in urban forest health; ecological restoration techniques; resource inventory and monitoring; dialogue among forest resource owners, managers, and users; collaboration among agencies and groups; how forest configurations influence forest use and benefits; and dissemination of information about urban forests and their management.

**Key Words.** Urban forest; arboriculture; landscape; collaboration.

Urban forestry research is thriving in the United States, due, in part, to widespread recognition of the increasing importance of forests in urban and urbanizing areas and the realization that research is critical to much-needed improvements in the management of these resources. Many factors are operating to increase the scope and complexity of urban forestry research and to pose new challenges for the future. The purpose of this paper is to briefly overview urban forestry and outline the future challenges and opportunities for urban forestry research in the United States.

## URBAN FORESTRY

Urban forestry involves the management of trees and associated resources in urban and urbanizing areas. This management may be planned and undertaken at several scales, ranging from the individual tree to the metropolitan landscape and beyond.

### Individual Trees and Plant Communities

In urban and urbanizing environments, individual or small groups of trees can be valuable for many different purposes (Dwyer et al. 1992). High tree values, combined with significant threats to tree growth, develop-

ment, and survival, have led to significant advances in the field of arboriculture. These advancements include a wide range of practices that help to improve tree selection, planting, growth, maintenance, and protection. Maintaining tree health is becoming more important than trying to remedy symptoms of poor tree health (Harris 1983; Lloyd 1997). As more attention is given to trees in diverse environments throughout the urban system, important challenges emerge for sustaining tree health (i.e., limited rooting space, soil compaction, tree damage, air pollution, etc.).

Management of prairies, savannas, woodlands, and forest ecosystem remnants within urban areas is increasing in significance and presents resource management challenges different from management of individual trees and developed landscapes. The practice of ecological restoration is developing rapidly to address the challenges associated with the restoration, management, and protection of these diverse areas.

### Comprehensive and Adaptive Management Across the Landscape

There is increased attention to comprehensive and adaptive management of forests across the urban landscape (Dwyer and Nowak 2000; Dwyer et al. 2000). The diversity of urban forest resources and their extension across land uses, property lines, and political boundaries call for management programs that bridge jurisdictions and employ multiple disciplines. A key element in managing urban forests in a regional context is the coordination of activities among different owners and managers across jurisdictions. Such collaborative stewardship should also involve users, as well as individuals and groups involved in the management of other urban components (e.g., commercial developers, city planners, utilities, and residents). Given the unique and varied character of urban forests found in particular settings, effective management requires different forest management strategies within an urban environment (e.g., by land use, land ownership, degree of development, and population charac-

teristics) and among urban areas (with different ecoregions, populations, and other attributes). Linkages with the management of exurban forests are increasingly important as insects; disease; fire; air and water pollution; exotic plants and animals; etc. migrate across the landscape and urban boundaries.

The diversity and connectedness of forest resources across an urban system demand comprehensive approaches to their planning and management. The complex interrelationships between urban forest components and air and water quality, wildlife habitat, utilities and other infrastructure, and the overall esthetic character of the community support the adoption of an ecosystem-based approach to natural resource policy, planning, and management, as well as collaboration with groups working to provide those outcomes. Because urban forests are dynamic systems, their management must also accommodate rapid changes in the extent, health, and use of resources over time. Implicit in adaptive management of urban forests is the ability to monitor progress and evaluate the effectiveness of management decisions.

### **RESEARCH EMPHASES**

The implementation of improvements in individual plant care, ecological restoration, and comprehensive and adaptive management of urban forests can be a difficult challenge for urban forest managers (Dwyer et al. 2000; Dwyer and Nowak 2000). To meet this challenge, a high level of research support will be required to improve the following areas: urban forest health; ecological restoration techniques; resource inventory and monitoring; dialogue among urban forest owners, users, and managers; collaboration among agencies and groups; understanding of how forest configuration influences forest use and benefits; and the dissemination of information about urban forests, their benefits, and their management.

#### **Urban Forest Health**

A recent Urban Forest Health Needs Assessment Survey conducted by the USDA Forest Service Northeastern Area State and Private Forestry (Pokorny 1998) found a disparity between the high level of interest on the part of urban forestry professionals in preserving the health of urban forests and the shortage of programs that specifically address and actively implement urban forest health management and preservation. Fewer than 25% of these professionals ranked the current general health of the urban forest in their

state or city as good or better. The most frequently cited adverse impacts on the current condition of urban forests were specific tree health problems. This survey suggests a need for more tree health-related research.

Increased concern over plant health and the high cost of dealing with unhealthy plants are among the reasons for increased research on plant health. Research can play a critical role in developing tree and forest health programs and methods for increasing their cost effectiveness. New techniques for plant health monitoring and information dissemination need to be developed to support comprehensive plant health care. Arboriculture is a labor-intensive industry operating in a limited pool of available labor (Thaler-Carter 1998). Two approaches hold the most promise for improved tree care and tree health. A better understanding of tree biology and a proactive approach to maintaining tree health may reduce the need for tree care services. Increased use of technology may help tree care operations become more efficient.

Research in this area addresses several critical concerns associated with the vitality and perpetuity of urban forests and their surrounding environment. In addition to targeting the key factors that directly affect tree and forest health, this emphasis area also includes research and development efforts to identify and deal with the indirect impacts of human activities (disturbance and pollution) on the extent and condition of urban forests. This research can provide managers with the means necessary to attain their management objectives in light of environmental and human threats to urban forest health.

#### **Ecological Restoration Techniques**

With increased interest in restoring a wide range of diverse plant communities in urban areas, and controversy over the appropriateness of some techniques for creating and maintaining these communities, there is an increasing need for research to guide ecological restoration efforts. Important needs include research that will help predict the future growth and development of these communities under various resource management programs. Also needed are restoration techniques that are acceptable to site users and nearby residents (Gobster 1997).

#### **Inventory and Monitoring of the Urban Forest Resource**

Comprehensive inventory and monitoring techniques need to be developed for the urban forest resource to

provide a base for understanding diverse urban resources and how they change over time, as well as for helping to improve resource management and resulting benefits. Research is needed that will support the development of new inventory and monitoring systems to (1) provide critical urban forest resource information; (2) identify forces for change in the urban forest and their influence on the extent, use, and management of urban forest resources; (3) provide a starting point for the development of predictive models to estimate the growth and development of urban forests in the future; (4) collect information that is essential to the implementation of important urban forest-related projects, such as air quality and water models; and (5) monitor the rates of change, extent, and health of urban forests to provide a foundation upon which evaluations of adaptive management programs may be based. There is a need for the establishment of permanent field plots and continuous data collection within urban areas to obtain long-term monitoring information about change in the urban forest resource.

#### **Dialogue Among Forest Resource Owners, Managers, and Users**

Given the large number of stakeholders involved, the diverse and dynamic character of their interests and activities, and the potential for their actions to have a substantial impact on the urban environment, an effective dialogue among urban forest owners, managers, and users is critical to effective management. The dialogue must serve complex needs. Interaction must occur among groups that are disproportionately experienced and educated in urban-forest-related disciplines and that have a broad range of valid concerns. Despite some heroic efforts, this dialogue has seldom been effective, and research is needed to guide new efforts at building and sustaining a useful dialogue that will help define and gain support for sustainable plans and management.

#### **Collaboration Among Agencies and Groups**

Given the large number of public agencies, not-for-profit groups, private firms, and other organizations that influence urban forests, their management, and use, the actions of many entities often have far-reaching implications for the structure, functions, and benefits of urban vegetation. Collaboration among these players is critical for effective management. Collaboration requires knowledge about the partners (e.g., What are the goals and objectives of urban landowners? Are

they willing to participate in cooperative management programs involving multiple holdings?).

There is a strong need to develop methods for collaboration among the many agencies and groups that focus on particular components of the urban forest, including single trees or other plants, restoration of urban plant communities, and various other components (i.e., street trees, parks, preserves, greenways, etc.). Also needed are improved methods of collaboration among public and private groups concerned with the urban forest. Because the management of urban forest resources can improve the environmental and social well-being of communities (Dwyer and Schroeder 1995; Feldman and Westphal 1999), the collaboration among multiple groups to meet common goals is important for the future. It is clear that collaboration among these diverse agencies and groups does not just happen on its own; special efforts are needed to make it happen and continue into the future. There is much to be learned from evaluating the successes and failures in previous collaborative efforts. This research emphasis is closely tied to the generation and distribution of information about forests and their management and use, because the availability of improved information is essential to collaboration.

#### **Understanding How Forest Configuration Influences Forest Use and Benefits**

Urban forest benefits are directly dependent on the configuration of vegetation and its location with respect to other natural and humanmade attributes of the urban environment (urban forest structure). To achieve community goals, managers need to design and work toward an appropriate vegetation structure to provide desired benefits. This task requires an understanding of how forest configuration influences the flow of benefits. Critical research on the linkages between urban forest structure and benefits needs to be conducted in a wide range of environments and at multiple scales. The task is substantial given the complexity of the urban forest and the urban environment, as well as the wide range of important benefits that can be provided.

Models that help predict benefits based on urban forest structure are likely to be particularly useful. Researchers are linking forest benefits with the structure of the urban forest through innovative modeling efforts. A new Urban Forest Effects (UFORE) model, which utilizes field data from across the urban ecosys-

tem, quantifies urban forest structure and associated functions (e.g., impacts on air quality and greenhouse gases) across a variety of urban areas (Nowak and Crane 2000). Previously developed models that predict scenic beauty, perceived safety, and probability of human use as a function of forest structure can also be instrumental in developing comprehensive management plans to enhance and maintain the beneficial functions of urban forests (Schroeder 1982, 1983, 1986, 1988, 1989; Schroeder and Cannon 1983, 1987; Schroeder and Anderson 1984; Lein and Buhyoff 1986; Schroeder et al. 1986; Dwyer et al. 1989). A critical need in urban forest modeling efforts is to build dynamic models that estimate changes in benefits as the forest changes over time. This model development requires improved information on the growth and development of trees and forests.

#### **Disseminating Information About Urban Forests and Their Management**

The key to adaptive management is applied learning: a process that is fundamentally driven by a continuous influx and application of new information (Lee 1993; Bormann et al. 1994; Maser et al. 1994). Thus, a critical responsibility of managers and researchers is to provide stakeholders, decision makers, and users with sources for information to enhance community-wide planning and management. The effective distribution of information is an essential precursor to users' (home owners, planners, educators, and researchers) ability to sustain urban forest benefits. As groups generate new information on urban forest structure, functions, and management technologies, the need for a reliable mechanism to ensure its dissemination in a useful form and timely manner continues to grow. Research can play a key role in helping to develop these dissemination systems, as well as developing the means for getting feedback from users on the effectiveness of the information and likely future user needs.

#### **SUMMARY AND CONCLUSIONS**

Expansion of the scope, complexity, and scale of urban forestry has brought new challenges for research to support the management of individual trees and plant communities, and increased attention to a landscape perspective for urban forestry research.

As research on urban forests and forestry increases in scope and complexity, the boundaries between urban forestry, arboriculture, landscape architecture, ecol-

ogy, and other areas tend to blur. As urban forest management becomes more comprehensive and the issues merge with those in rural areas, linkages with research in exurban areas will also increase. The urban-rural research linkages have also increased as a result of better recognition that physical, biological, and social processes that influence forests operate across the urban to rural continuum.

Future urban forestry research efforts are likely to be most effective if they involve collaboration with managers, teams involving researchers from a wide range of disciplines, and a focus on multiple scales across the urban landscape (i.e., from single trees to urban and urbanizing landscapes) in support of collaborative and adaptive management. This integration of the landscape, ecological, and tree-care research in urban forestry will provide for comprehensive and adaptive management to sustain urban forest structure, health, and benefits over the long term.

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**Résumé.** La recherche en foresterie urbaine promet de continuer à être une partie intégrante de la croissance et du développement de la foresterie en milieu urbanisé aux États-Unis. Pour l'avenir, un emphase accrue sera mise sur la recherche en support de l'entretien des arbres et des autres végétaux, sur la restauration écologique ainsi que sur la gestion globale et adaptée des espaces verts. Une emphase particulière sera nécessaire envers la recherche pour guider les améliorations au niveau de la santé de la forêt urbaine; des techniques de restauration écologiques; de l'inventaire de la ressource et de son suivi; du dialogue entre les diverses classes de propriétaires de la ressource forestière, de gestionnaires et d'utilisateurs; de la collaboration entre les diverses agences et groupes; du comment les configurations forestières influencent l'utilisation de cette dernière et ses bénéfices; et, de la dissémination de l'information sur les forêts urbaines et leur gestion.

**Zusammenfassung.** Die Forschung in urbaner Forstwirtschaft in den USA scheint eine wichtige Rolle zu spielen im Wachstum und Entwicklung von Forstwirtschaft in urbanen und daran angrenzenden Gebieten. In Zukunft wird eine stärkere Betonung auf Forschung in Baumpflege, ökologische Re-

naturierung und umfassendes Landschaftsmanagement erwartet. Eine besondere Bedeutung soll die Forschung erhalten, die sich mit folgenden Themen beschäftigt: Verbesserungen in der Forstgesundheit, Renaturierungstechniken, Quellenerhebungen und Überwachung, Dialog zwischen Forstbesitzern, -managern und -nutzern, Kollaboration zwischen Agenturen und Gruppen, Einfluss von Waldformen auf Nutzung und Vorteilen sowie Bearbeitung von Informationen über urbane Forste und ihr Management.

**Resumen.** La investigación en Dasonomía Urbana promete seguir siendo una parte integral del crecimiento y desarrollo del bosque en áreas urbanas en los E. U. El futuro traerá un incremento en la investigación del cuidado de árboles y otras plantas, restauración ecológica, manejo comprensivo y de adaptación en el paisaje. Un énfasis particular será necesario en la investigación para guiar los avances en la salud forestal urbana; técnicas en restauración ecológica, inventarios y monitoreo de recursos; diálogo entre propietarios del bosque, administradores y usuarios; colaboración entre agencias y grupos; cómo las configuraciones del bosque afectan su uso y beneficios; y diseminación de información acerca de los bosques urbanos y su manejo.

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