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PROPOSAL FOR URBAN FOREST HEALTH MONITORING IN THE UNITED STATES

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ABSTRACT: Urban areas cover approximately 3.5% of the total land area of the coterminous United States, contain more than 75% of the U.S. population, and support about 3.8 billion trees. Yet little is known about the status of the forest resource in these areas or how it is changing. This paper details a proposal to create a national urban forest health monitoring program within the USDA Forest Service's Forest Health Monitoring Program that would establish an estimated 11,735 permanent urban plots nationwide. These plots would be resampled on an annualized 5- or 7-year cycle in the East and on a 10-year cycle in the West. Annual reports would provide current information on urban forest health, structure, and functions, and associated monetary values for each state/region and the nation. The information gathered on urban forest characteristics, particularly rates of change, would provide essential information for managing the urban forest resource and improving forest health in urban areas.

KEY WORDS: Urban forestry; forest health

People are having an ever increasing impact on local, regional, and global environments. This impact is particularly significant in and around urban areas (e.g., cities, towns, villages). Urban forests (i.e., trees in urban areas) can mitigate certain detrimental human impacts and improve environmental quality and human health. Urban forests can provide clean air and water, recreation, energy conservation, carbon storage, protection from ultraviolet radiation, cooler air temperatures, habitat for wildlife, forest-based products, employment, and aesthetic values, and enhance the social and psychological well-being of millions of Americans. A valuable national resource that will continue to increase in extent and importance in the years ahead, urban forests face many pressures (e.g., insects, diseases, storms, and pollution) that can affect forest health and numerous related benefits.

Trees in urban areas comprise a significant national resource. Covering 3.5 percent of the total land area and housing more than 75 percent of the U.S. population, urban areas support about 3.8 billion trees or 2.8% of the total canopy cover in the coterminous United States. The urban forest resource varies in extent across the United States. States with the highest percentage of total tree cover in urban areas include New Jersey (22.3%), Massachusetts (14.4%), and Connecticut (14.0%). States with the largest urban tree populations generally are in the South and Northeast, and include Georgia (232.9 million), Alabama (205.8 million), and Ohio (191.1 million) (Dwyer et al. 2000; Nowak et al. 2001).

Although urban forests are a significant resource affecting the vast majority of the population, little is known about the nation's urban forests, how this resource is changing, or the factors that might lead to changes in urban forest structure and health. The purpose of this paper

is to detail a current proposal for a national program and methodology to monitor the long-term health, structure, and functions of urban forests.

PROGRAM JUSTIFICATION

In 1997, a National Research Council report titled "Forest Lands in Perspective" recognized that urban and community nonfederal forests are the fastest growing forests in the United States and recommended strengthening federal forest health monitoring of these forests. In 1998, USDA Forest Service Chief Michael Dombeck developed a Natural Resource Agenda that emphasized sustainable development of communities, and Deputy Chief Phil Janik released an action strategy for State and Private Forestry that would increase forest health monitoring in urban areas. In 1999, former USDA Secretary Dan Glickman noted: "We still have plenty of work to do to make Americans take notice of the dwindling natural resource base in their cities" [1]

In a survey of forestry professionals regarding urban forest health needs, less than 25% of the respondents ranked the overall health of the urban forests in their state as good to excellent, 99% indicated that preserving the health of community forests should be an integral part of urban and community forest programs, and more than 90% identified long-term tree care and maintenance programs as critical to preserving the health and sustainability of urban forests in the Northeast (Pokorny 1998).

To date, forest health inventory and monitoring do not occur in urban areas. Some cities occasionally inventory their street and park tree populations, but these inventories only cover a limited portion of the total urban forest and are conducted in a small proportion of urban areas nationally. Comprehensive inventorying and monitoring of urban forests in selected cities has been started as part of the research program in the Northeastern Research Station of the USDA Forest Service. The methods and analysis tools developed by this program will be used to help monitor urban forest health on a national basis.

The proposed program would fill a data gap within the Forest Inventory and Analysis (FIA) and Forest Health Monitoring programs. Closing this data gap will allow for a better and more comprehensive assessment of the current and changing nature of the nation's total tree resource. This program will also allow the Forest Service to detect and respond to changes in the nation's urban forest resource, thereby helping to ensure long-term urban forest health and increased quality of life for the vast majority of Americans that live, work, and recreate in urban areas.

PROPOSED METHODS

The proposed urban forest health monitoring program will be incorporated within the current USDA Forest Service's Forest Health Monitoring Program. Permanent plots will be

[1] Glickman, D. 1999. *Building cities of green*. Speech delivered at 1999 National Urban Forest Conference in Seattle, Washington.

established in urban areas based on the FIA's existing plot selection procedure. The current sampling intensity is about one plot per 6,000 acres. All FIA plot locations within urban areas of each state would be sampled in the urban forest health monitoring program.

Definition of Urban Areas

Boundaries of urban areas are based on data from the U.S. Bureau of the Census. An **urban area** is defined as the area occupied by the union of three census-defined urban designations: 1) urbanized areas, 2) places that contain some urbanized areas within their boundaries, and 3) urban places. Areas totally surrounded by urbanized areas but not within an urbanized area or place boundary also are considered to be urban areas.

Urbanized areas have a population of 50,000 or more and a minimum population density of 384 people per square kilometer (U.S. Dept. Commer. Bur. Census 1994). Individual places exist both within and outside of urbanized areas. A **place** is defined by the Census Bureau as a concentration of people. A place may (incorporated) or may not (census-designated) have legally prescribed limits, powers, or functions. To be designated as a place, the concentration of population must have a name, be locally recognized, and not be part of any other place. Of the 23,435 places in all 50 states from the 1990 census, 19,289 were incorporated and 4,146 were census-designated. A place with at least 2,500 people that is located outside of urbanized areas is designated as an **urban place** (U.S. Dept. Commer. Bur. Census 1994).

Plot Selection / Distribution

Plots in urban areas would be sampled using the FIA's sampling grid. Given the existing distribution of urban land in the United States, approximately 11,735 urban plots would be sampled (Table 1). Data are collected on each plot regardless of the amount of trees in the plot as all plots provide data with which to monitor change and thus yield information on urban forest health.

Table 1. Estimated plot distribution for urban forest health monitoring in the United States (total estimated urban plots = 11,735)

State	No. of Plots	State	No. of Plots	State	No. of Plots	State	No. of Plots	State	No. of Plots
AK	70	ID	40	MA	285	NM	95	SD	25
AL	350	IL	380	MI	310	NY	420	TN	305
AZ	380	IN	210	MN	280	NC	265	TX	1,095
AR	145	IA	130	MS	140	ND	20	UT	110
CA	1,130	HI[a]	45	MO	235	OH	410	VT	20
CO	180	KS	110	MT	180	OK	330	VA	365
CT	170	KY	140	NE	45	OR	95	WA	235
DE	25	LA	225	NV	135	PA	345	WV	45
FL	760	ME	120	NH	70	RI	40	WI	190
GA	345	MD	190	NJ	285	SC	180	WY	35

[a] Includes Puerto Rico, Virgin Islands, and Pacific Islands.

Plot Size and Design

The plot size and design to be used in urban areas are currently under investigation. The efficiency of the standard forest plot design of a cluster of four 1/24-acre circular plots is being compared with the efficiencies of various single-circle plot designs. A decision on urban plot size and design will be made in February, 2001.

Units of Analysis – Nation / State / City Analyses

Reports will present data aggregated to the state or regional level (depending on sample size in state) and for the entire nation. Because the existing sampling framework for urban forest health monitoring provides insufficient detail to reveal information at the city / town level, states and cities will have the option to fund an increased number of urban plots. These enhanced data sets could be used to increase data resolution within the state, compare different regions within a state, or develop reports on urban forest structure, function, and change for individual cities to improve the management of this resource at the local level.

The Urban Forest Effects model (UFORE) could be used to assist cities in monitoring the health, structure, and functions of their local urban forests (Nowak et al. 1998; Nowak and Crane 2000). Fifty to 200 randomly located plots would be sampled depending on city size. These plots would be stratified (if possible) by land-use type to provide information for individual land-use classes and the entire city. Random plot-selection programs for geographic information systems have been developed, and field manuals and field data-recording programs are being developed to assist in data collection at the city scale. Local data could be collected using trained volunteers or forestry professionals. Quality assurance and control of these city data would be the responsibility of the local data collectors. City data collection would follow national protocols for urban forest health monitoring and results would provide useful information for planning and management at the city level. City reports are currently being developed for Atlanta, Boston, Brooklyn[2], Baltimore, Calgary, Jersey City, New York City, Philadelphia, Syracuse, and Toronto.

Sampling Frequency

The proposed national urban forest health monitoring plots will be resampled on an annualized 5- or 7-year cycle in the East and on a 10-year cycle in the West, to correspond with the FIA's current data collection protocol. With an annualized inventory, 1/5, 1/7, or 1/10 of the state (depending on state and region) would be inventoried every year. A running average of health, structure, and function data would be reported annually. After the first cycle of data collection (5, 7, or 10 years), reports will begin to incorporate data on urban forest change.

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[2] Nowak, D.J., D.E. Crane, J.C. Stevens, and M. Ibarra. In review. *Brooklyn's urban forest*. Gen. Tech. Rep. NE-GTR. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station.

DATA COLLECTION AND ANALYSES

Data collection will follow FIA's standard data collection procedures with slight modifications to allow for data analyses using UFORE. Monitoring results will include information on:

- Urban forest structure and health (e.g., species composition, tree cover and density, tree health (crown deterioration; tree damage and mortality), leaf area, exotic species distribution).
- Forest effects on air pollution (ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter).
- Effect of trees on building energy use and carbon dioxide emissions.
- Carbon storage and annual carbon sequestration by urban trees.
- Insect and disease potential (e.g., gypsy moth and Asian longhorned beetle).
- Pollen allergy ratings.
- Tree transpiration and potential water use.

Monitoring results will be reported annually for each state/region and the nation. These reports will detail information on urban forest health, structure, and functions, and associated monetary values. Information on urban forest characteristics, particularly rates of change, will provide essential information for managing the urban forest resource and optimizing environmental quality and human health in urban areas.

PROGRAM COST / PILOT TESTS

Program costs include costs of plot setup, crew training, plot measurement, quality control and quality assurance work, data analysis, and report generation. Based on an estimated 2,100 urban plots measured each year nationally, the total urban forest health monitoring program will cost approximately $3 million per year. Final cost estimates will be refined based on pilot testing of forest health monitoring methods in urban areas. It is proposed that one or two states that already are on the annualized inventory be pilot tested this year. Pilot states will be selected in February, 2001.

CONCLUSION

Urban forest health monitoring will provide essential information on the health of urban forests and how urban forests are changing. Information provided by national urban forest monitoring will facilitate better urban forest management and ultimately improve environmental quality and human health in urban areas. Monitoring methods will also provide valuable information for cities to assess and manage their local forest resources.

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