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THE PINCHOT INSTITUTE: TOWARD MANAGING OUR URBAN FOREST RESOURCES [1]

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Though much has been written about the intriguing scientific challenges awaiting man in space, the most significant challenge of all is here on earth. We now realize that our collective decisions influence man's tenure on this planet. Environmental problems are challenging us to be doubly resourceful in identifying problems and finding solutions now, so that we can live in harmony with our environment through the decades ahead.

Forests and trees are a big part of our environment. Americans have realized this since the turn of the century, and have responded by applying scientific principles to protect, and utilize, this vast and valuable forest resource. But now, with environmental calamities threatening, a whole new environmental viewpoint is needed.

At one time forests and trees were thought of as being far off in the country far removed from the city dweller. Today they are at the doorsteps of ar ever-growing metropolitan centers, where they affect man, and in turn, are affected by man. This proximity produces problems that only a responsive, dedicated, and coordinated scientific effort can hope to solve. This was the philosophy behind the establishment of the Pinchot Institute of Environmental Forestry Research.

Gifford Pinchot's autobiography, "Breaking New Ground," documents the rise of forestry and conservation in America. In this tradition, the Pinchot Institute of Environmental Forestry Research attempts to provide scientific answers to some of today's most challenging environmental problems in urbanized areas. The Institute is a focal point for cooperating scientists working toward maximizing human benefits from management of urban forest resources.

Urban forestry involves those aspects of resource management dealing with urban man's need for the tangible and intangible benefits associated with forested areas. It includes the management of environments ranging from small, tree-shaded parks in the city to landscaped transportation corridors and woodlands in the rural areas that also serve our huge, sprawling, urban complexes. Where urban forests exist, they modify and improve living conditions by furnishing sites for recreation, and protecting and maintaining water supplies. Urban forests also provide sanctuary for wildlife, screen industrial and highway developments, improve human comfort by screening sun, wind, and noise, improve air quality and enhance the setting for aesthetic enjoyment.

Wrestling with the problems of cities is not an

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entirely modern occupation, or preoccupation. In 1744 an Englishman, Dr. John Armstrong, in *The Art of Preserving Health,* admonished his readers, "Fly the rank city, shun its turbid air: Breathe not the chaos of eternal smoke and vile corruption."

"Flying" the city is a solution only for the relatively few urban residents who can leave. Finding viable long-term solutions to complex urban problems has traditionally been the task of sociologists, city planners, architects, civil engineers, psychologists, and economists. Now the urban forester has joined the effort.

To many, the term "urban forestry" is a paradox. The implication is that forestry does not exist in urban areas and management of urban vegetation is the sole domain of the arborist, horticulturist, and landscape architect. But the dividing line between these professions and forestry is extremely vague. In fact, all are engaged in managing urban forests. While the horticulturist knows how to develop and grow cultivars, and the landscape architect utilizes forest vegetation to enhance landscape quality, the forester contributes his knowledge of managing vegetative systems in a long term perspective.

The term *urban* has traditionally been used with reference to inner city areas. More contemporary use should include the surrounding suburban areas, some almost rural in character, that interact with urban networks. Modern transportation systems allow people to commute long distances to work in the city. Thus, urban social values and influences are transported far beyond city limits.

Forestry is the management of forests to provide continuing human benefits. The term implies concern for sustained multiple use to provide a variety of all forest products and services. These concepts at first glance appear to divide the practice of forestry, arboriculture, and horticulture. The horticulturist often plans vegetation for immediate, aesthetic benefits, while the forester views vegetation from a longer-term, multiple use perspective. Both can contribute to managing urban forests to maximize benefits, but to do so effectively, both must change slightly from their traditional viewpoints in order to deal with the range of problems which face the urban forest manager.

The *urban forest* is a flexible concept that encompasses rows of street trees and clusters of trees in city parks, green belts between cities, and eventually forests that are more remote from the inner city. The urban forest occupies that part of the urban ecosystem made up of vegetation and related natural resources found in urban, suburban, and adjacent lands, regardless of ownership. As we move across the urban-rural gradient, the mix of benefits provided by the urban forest changes. The limits of the urban forest cannot be defined by a line on a map. More importantly, the *urban forest* provides a conceptual framework within which to organize a research program to maximize the benefits that forests can contribute to improving urban environments.

Organization of the Pinchot Institute

The Pinchot Institute is located at the U.S. Forest Service's Northeastern Forest Experiment Station headquarters in Upper Darby, Pa. The two branches of the Institute deal with inhouse Forest Service research, that is research conducted under the administrative structure of the Northeastern Forest Experiment Station, and with nine northeastern universities which form the Consortium for Environmental Forestry Studies.

Formally organized in March, 1971, the Consortium membership includes: The Northeastern Forest Experiment Station of the U.S. Forest Service; The University of New Hampshire; The Massachusetts Agricultural Experiment Station; The University of Connecticut; Yale University; The State University of New York, College of Environmental Science and Forestry; Cornell University Agricultural Experiment Station; Princeton University; Rutgers University; and the Pennsylvania State University.

The Consortium is run by an executive committee elected from member universities and a representative appointed by the Forest Service.

Inhouse Research

One Forest Service inhouse research unit is located at Amherst, Massachusetts. It is a multidisciplinary research team that is developing

policy guidelines to maximize social benefits from urban forests. Studies of urban wildlife, recreation, landscape design, and land-use planning are now underway.

The other Forest Service unit is located at Pennington, New Jersey. It's mission is to develop management guidelines to maximize the physical benefits obtainable from urban forest management. The effects of trees on urban microclimate, noise, municipal water quality, and improvement of urban trees are being studied.

Consortium Research

Pinchot Institute scientists pool their resources and knowledge to attack a broad array of urban forestry problems — many of which could not be approached by a single institution or agency. To avoid duplication of research effort and to insure coordination of the entire program, Consortium scientists are organized into working groups according to their major research interests. The 9 working groups comprise: air, water, land-use, wildlife, physical amenities, social amenities, soil, genetics, and insects and disease.

Working groups develop problem analyses, set research priorities, and submit integrated research proposal packages to the Consortium Executive Committee. Recommendations of the Executive Committee are passed on to the Northeastern Forest Experiment Station for funding consideration. Some Consortium research is funded by other federal and state agencies and by private sources. Study proposals usually involve several scientists from one or more of Consortium institutions, plus scientists from one of the two Forest Service research units.

Research results are disseminated through professional journals, publications of the Northeastern Forest Experiment Station, and through symposia dealing with specific urban forestry issues. Proceedings have been published for each of the eight symposia held over the past six years.

Research Programs

Improving air quality

The Consortium's air quality working group is trying to develop management practices to use trees to reduce air pollution, and correspondingly reduce pollution damage to urban trees.

At Yale University's School of Forestry and Environmental Studies, Consortium scientists have completed an experiment to determine if, how, and to what extent leaves remove heavy metal pollutants from our air. Using an electron microscope, they found significant particle concentrations of aluminum, chromium, nickel, iron, lead, sodium, and zinc on leaf surfaces. Although the particles were extremely small, they were very similar in size and shape to the air-borne particles most detrimental to human health. Microbial ecology on leaf surfaces was found to be significantly altered by these particles.

A number of Consortium institutions are studying how pollution damages trees. A two-year study at Rutgers University showed that the gaseous pollutants hydrogen fluoride caused considerable local tree damage in New Jersey. Trees most severely affected were Scotch pine, white pine, several species of oak, spruce and fir. While some trees took several years to recover from exposure to hydrogen fluoride, others produced new growth and resumed a normal appearance soon after exposure. On the positive side, researchers found that American holly, white birch, London plane, flowering dogwood, magnolia, mulberry, apple, and Norway maple are relatively resistant to fluoride air pollutants.

Improving water quality

Researchers in the water working group are trying to determine the effect of urban man's activities on water quality. They are also looking at forests as a possible medium for disposal of treated municipal wastewater.

Scientists from Pennsylvania State University and the Forest Service are studying the feasibility of using the biosphere — soil and vegetation — as a "living filter" to remove effluent from sprayed sewage sludge. They found that forests can purify effluent for groundwater recharge with the additional benefit of increasing tree growth. Under optimal levels of effluent application, average diameter growth increase of 186% were found for red pine, 254% for white spruce, and 340% for red maple and sugar maple.

Improving microclimate

Urban forests play an active role in regulating physical attributes of the urban environment. The Pinchot Consortium's working group on physical amenities is looking at ways in which trees can be used to improve the metropolitan microclimate and to reduce home energy consumption.

Researchers at the University of Connecticut used a line of instrumented towers placed along the edge of a parking lot-forest interface to determine how the forest influences local energy relationships. They found that temperature was reduced by 2-3 degrees C during the day as air left the parking lot and entered the forest. At night, temperature declined more slowly in the forest than over the parking lot. Some 10-20 percent of the heat produced on the parking lot surface was transferred to, and dissipated in, the adjacent forest, most of it near the forest edge. It appears that trees are most efficient at dissipating heat if placed in strips three times as wide as the trees are high.

Scientists at the State University of New York (SUNY), College of Environmental Science and Forestry, at Syracuse, are also exploring the effects of forest vegetation on metropolitan climate. Their research proved that trees can contribute significantly to human thermal comfort and they are developing management guides to show how trees can be used to enhance human comfort in urban environments.

Trees can be used to reduce energy requirements for home heating and cooling. Approximately 1/3 of the energy used to heat homes is lost due to air infiltration. Since the average home changes air once each hour, approximately 9 tons of air must be heated daily. Princeton University and Forest Service scientists are studying the feasibility and utility of using forest vegetation to shelter homes from the wind and thereby reduce heat loss due to air infiltration. The project is set up in townhouses in Twin Rivers, New Jersey. Wind speed and pressure, air infiltration, and temperature relationships were measured both before and after installation of a single row of 25 foot white pine trees around the townhouses. Initial results indicate that trees can produce a heating energy savings of up to 40 percent under optimal conditions. Moving mature trees to determine optimal spacing is expensive, so the investigators will use a wind tunnel, simulated forests, and miniature models of homes in future studies.

Reducing noise

The Consortium's working group on physical amenities is looking at the use of trees to reduce noise in urban areas. Researchers at SUNY have found that narrow bands of trees are ineffective as noise barriers. Because of limited space in urban areas, large plantings of trees for noise reduction are probably not feasible. However, trees can be effective when used in conjunction with terrain features and urban structures.

Penn State and Forest Service scientists are analyzing the complex problems of sound attenuation in a forest. While tree boles and bark were found to absorb only a small fraction of noise, noise was found to be effectively scattered by tree trunks and branches so that it can be absorbed by other structural elements of the forest. The forest floor is probably the most efficient absorber of sound. Researchers are now determining how the composition, structure, and moisture of forest ground cover can be altered to enhance sound absorption.

Preserving urban open space

The presence of forest vegetation enhances urban living, but how much green space should be left in cities and where should it be located? How can urban forest and related open space be preserved in face of the growing demand for urban land? By addressing these questions, the Consortium's land-use working group is trying to find ways to preserve and maintain forests and open space in and around cities.

SUNY scientists showed that zoning is not a very effective way to preserve urban forests and open space. They are now testing new land-use control systems that preserve forests and open space while trying to minimize the impact on economic development. These systems are being evaluated in terms of their economic, social, and environmental effectiveness, and their administrative-political feasibility.

Researchers at Princeton University are evaluating the effectiveness of present state and local government ordinances designed to maintain urban vegetation. They concluded from a survey of U.S. and European scientists, architects and land planners, that few ordinances specifically spell out human, ecological, and physical constraints on removal of urban forest vegetation. Even where these conditions are specified, administrative programs to evaluate the effects of proposed land development changes seldom exist. The researchers also found that ordinances are seldom effectively enforced because they are vaguely stated. Consequently, the researchers concluded that existing ordinances are not effective mechanisms to influence tree planting, maintenance, or removal under conditions of rapid urbanization.

Encouraging wildlife

Scientists in the urban wildlife working group are concerned with the wide variety of birds and small mammals found in most urban areas. Little information exists on how to manage urban wildlife. Before management programs can be developed, research is needed to answer a variety of questions. How do habitat requirements differ for urban wildlife as compared to wildlife found in rural or remote forest areas? How does wildlife adjust to stress imposed by the urban environment? How do urban dwellers benefit from wildlife and what management practices can enhance these benefits?

Penn State and Forest Service scientists, for example, are surveying forest types found in three urban forest zones — inner city, transition, and rural — for the wildlife species that live there. They will correlate this information with availability of food, water, and type of vegetation — the things that regulate the variety and number of animals an area can support. Their results will be used to prescribe management practices to improve living conditions for urban birds and mammals most attractive to man.

The urban landscape

Some forest values can be measured easily in physical units, while others, such as beauty of a forested landscape, can only be evaluated subjectively. Finding ways to evaluate and quantify these more elusive forest values is the task of the Consortium's social amenities working group.

Researchers at the University of Massachusetts have developed a Metropolitan Landscape Planning Model (METLAND), that can be used to assess the impact of urban land development on urban forest resources. The Model predicts changes in land and water resource-use patterns likely to occur under alternative land development programs.

Improving urban soils

Wherever trees grow, they do best on good quality soil. The process of urbanization has drastically disturbed millions of acres of soil. The resulting effects on soil properties and on the subsequent success of tree plantings and residual forest vegetation are largely unknown. The soils working group is investigating these effects and trying to find ways to avoid or reduce soil damage due to urbanization.

University of Massachusetts scientists are evaluating and classifying urban soils based on compaction, nutrient loss, and water loss — factors that strongly influence development of tree root systems. This information will help to identify soil conditions that encourage or inhibit tree growth and survival.

In related work, scientists at the University of New Hampshire are applying a compost of ground hardwood bark and sewage sludge to trees in greenhouses to determine if these soil additives enhance survival of trees exposed to urban stress. Studies will eventually be expanded to full scale field tests. This will represent a first attempt to restore the productive potential of urban soils.

Developing better urban trees

Stresses imposed by the urban environment affect trees in much the same way as they affect people. Urban trees suffer from the shock effect of transplanting, cramped growing space, inadequate water, exposure to temperature extremes, air pollution, drought, and soil compaction. Health, longevity, and physical ap-

pearance suffer. Some trees survive the stresses of urban life while others quickly succumb. The genetics working group is selecting and breeding trees to withstand the rigors of city life.

At Penn State, different tree species and varieties are being tested for tolerance to air pollution, road salt, drought, and other urban stress conditions. Trees that perform best will be selected for breeding and development of superior varieties. Eventually trees that are better suited to urban growing conditions will result.

Another aim of the Consortium's genetics group is to provide comprehensive information about the relative adaptability of various tree species to urban stress. To help choose the right trees for a particular use and urban site condition, Penn State scientists have organized urban tree data into a "genetic information system." Data for the system were collected through a survey of municipal arborists, nurserymen, and other researchers, who helped decide which tree characteristics are most suitable for different urban site conditions. When fully operational, the system will facilitate better selection of tree varieties for specific urban uses and conditions.

Summary

An urban forestry research program must have contributions from many disciplines. Research problems range from understanding the intrinsic values associated with a child's observation of an early spring flower in center city, to helping design policies and programs that insure metropolitan and regional government cooperation in management of urban forest resources.

At the time of his death in 1946, Gifford Pinchot was making plans for an international conference on conservation. Adhering to many of the precepts on which this conference was conceived, the Pinchot Institute of Environmental Forestry Research is breaking new ground in urban America by conducting research to enhance the relationship between urban man and forest resources. As the trend toward urbanization continues, benefits derived from urban forests promise to grow in importance and touch the lives of greater numbers of people.

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Abstract. In 1971, the USDA, Forest Service established the Pinchot Institute of Environmental Forestry Research to deal with forest-related environmental concerns in urban areas. The Institute is named in honor of the first Chief of the Forest Service; one of America's foremost early conservationists. Within the Pinchot Institute, the Forest Service and nine northeastern universities have joined together to form the Consortium for Environmental Forestry Studies. Through this program, scientists at institutions throughout the Northeast are developing information needed to solve problems of policy formulation, regional planning, and management of urban forest resources. Though the research is done in the Northeast, much of it is applicable to management of urban forests throughout the Nation and abroad. By coordinating Forest Service research with that of other Consortium members, there is a much greater chance of meeting the Institute's overall objective — to determine how trees and forests can best serve the needs of urban man.

Abstract.

Felix, Robert. 1976. **Tree cabling and bracing.** Weeds, Trees, and Turf 15(11): 32.

Among the many services that the truly professional arborist has available for his clientele, cabling and bracing are the least appreciated until their need is demonstrated. After a storm, fallen trees, broken leaders, and split crotches make tree owners very much aware of what might have been prevented had their trees been properly cabled or braced. Although preventative cabling and bracing is important, remedial treatment can be a valuable service available from the true professional. Needless to say many trees are critical to a particular landscape. If they are damaged in a storm it is imperative that every attempt be made to restore them. When diagnosing a tree care situation keep cabling in mind. It is an important service as a preventative as well as a remedy.