ODC 900.0:624+27

URBAN FORESTERS NOTEBOOK

Edited by Silas Little

FOREST SERVICE GENERAL TECHNICAL REPORT NE-49

1978

Forest Service, U.S. Department of Agriculture

Northeastern Forest Experiment Station

370 Reed Road, Broomall, Pa. 19008

STEERING COMMITTEE

Cochairmen

Silas Little

Northeastern Forest Experiment Station, Pennington, N.J.

Richard F. Watt

Northeastern Area State and Private Forestry, Broomall, Pa.

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State University of New York, College of Environmental Science and Forestry, Syracuse

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Fairmount Park Commission, City of Philadelphia, Pa.

Gary Moll

Maryland Forest Service, Mechanicsville, Md.

FOREWORD

The information required to practice urban forestry is drawn from many disciplines, so the urban forester must turn to a variety of organizations, journals, and books for source material. The Forest Service encompasses many of the fields that are important to urban forestry, and this notebook is an attempt to coordinate and summarize useful information--abstracts of current information or practice, each with an annotated list of references. We plan to call upon other professionals to write on additional topics.

We hope that the loose-leaf format will help keep the notebook current; new or updated material can easily be inserted, and copies of articles listed in the references can be added.

On the following page you will find a request for feedback in which we solicit your comments on the usefulness of the notebook in its present form, and on how it might be improved. After you have read the notebook, please take a few minutes to let us know your opinion.

--Lee Herrington

COMMENTS ON THE URBAN FORESTERS NOTEBOOK

Many of you will have comments, either pro or con, to make on the Urban Foresters Notebook. We have included this tear sheet to make it easier for you to get these comments to the Notebook Committee and also to let us know if you want your name on the mailing list to receive updates to the Notebook.

When you make your comments you might want to consider some of the questions which are of real concern to the Committee. For example, do you think that a publication such as this is of high, moderate, or little use to urban foresters? We wonder whether we have left out important topics or included ones that practitioners may think should be omitted. In developing the Notebook, in terms of both content and format, it would be helpful to know which papers you think particularly useful--and which are of little or no use.

Please take a few minutes to jot down your thoughts on these or any other aspects of the Notebook and give this page to the person at the Conference registration desk or mail it to:

Albert N. Foulger
Asst. Director, Research Planning and Application
Northeastern Forest Experiment Station
370 Reed Road
Broomall, Pennsylvania 19008

If you have no comments but want your name on the mailing list, please print your name and address on the back of this page and give it to the secretary or mail it to the above address.

Add my name to the Urban Foresters Notebook mailing list.

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INTRODUCTION

URBAN FORESTRY is the management of the vegetation in urban and urbanizing areas. For our purposes we have taken URBAN AREA to mean an area where man has significantly affected the "natural" ecosystems by creating areas for residence and commerce.

The urban forest, which comprises all the trees and associated vegetation within an urban area, is made up of several subsystems. The street tree subsystem probably has received the most intensive management. On the other hand the park subsystem probably has the longest history of management, going back to managed "commons" and European community woodlots and forests. Only recently have the trees and vegetation on urban private lands, both residential and institutional, been actively considered part of the urban forest albeit the most difficult to manage.

Management of the urban forest--or parts of it--rests on two bodies of knowledge. One consists of the arborist's techniques that center around the breeding, selection, and propagation of trees suitable for urban sites, the protection of these trees from a host of enemies, the repair of damaged trees, and the shaping of the trees into suitable forms.

The second approach is based on techniques of ecosystem manipulation which foresters have developed over many years to achieve management goals. At present these two approaches are converging to form a comprehensive methodology of urban forest management.

Urban societies' objectives for the management vary greatly, usually dealing with the "in place" values of the trees. Noise reduction, modification of microclimate, screening of unsightly views, and provision of natural beauty for urban people rank high in the objectives for growing trees in inner cities, as does providing a habitat for songbirds, squirrels, and other wildlife, especially in parks. Recreation sites are important and the form varies with location: playgrounds and amenity spaces predominate in the inner cities, while sites for picnicking, hiking, biking, horseback riding, and similar activities are more common in suburban areas. "Natural areas" for recreation, nature education, and research are also in demand and are needed within the urban zone.

Problems in growing trees to meet these objectives are many and varied. Soil treatments may be needed to permit good survival and growth. Air or soil pollution, sometimes aided and abetted by disease or insects, may limit the choice of species or require remedial measures. Shade trees may need pruning to permit the passage of utility lines or vehicles without damage by tree branches even though this may increase disease problems or lower esthetic values. Along streets of cities and towns, and in recreation areas and developments, trees may suffer injury to boles or root systems that may require costly remedial treatments and which might have been prevented by proper planning. In suburban and developing areas, construction may damage residual stands or may be inappropriate to the site. In the former case, proper techniques of protection can save trees while in the latter, more informed planners are needed.

Management systems must be developed which meet both societies' objectives and the ecological requirements of desirable tree species, plant associations, or wildlife. City climate or other physical attributes of urban life may be controlled or ameliorated through management. Or perhaps management will be dictated by the need to provide high-quality water for municipal water supplies, or to dispose of waste water or sludge in ways that groundwater supplies are not contaminated. One fact of urban forest management is clear--it must be "multiple-use," or rather "multiple-benefit," management.

Based on this view of urban forestry, we have organized the notebook into the following four sections:

I. Benefits Provided by Urban Trees and Stands

II. Culture and Protection of the Urban Forest

III. Management of the Urban Forest System

IV. Interface with Land-Use Planning

A great deal of information is available in the first three of these areas, while the last is relatively new and developing rapidly.

This reference notebook does not attempt to supply all the answers practicing urban foresters need, but we hope it will be of value in summarizing information and in providing leads toward more detailed sources. In many instances the State and Private Forestry Branch of the U.S. Forest Service may be able to supply single copies of the papers listed at the end of each section, particularly if the paper is a Forest Service publication.

the NOTEBOOK COMMITTEE.

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NOTE: List of topics is not complete; your suggestions are welcome.

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EFFECTS OF TREES AND WOODLANDS ON MICROCLIMATE AND HOME CONDITIONING COSTS

Gordon M. Heisler

Northeastern Forest Experiment Station
University Park, Pa. 16802

The effects of trees on climate can be viewed on several scales. The microscale is that of the neighborhood, the block, or the individual building site. Climate on the scale of that found in large cities is usually considered in the mesoscale range. We believe that trees significantly affect the mesoscale climate of cities; but the microscale effects of trees on climate are more dramatic. For residential-energy use, microscale effects of trees are most important for the 69 percent of American households that occupy single-family dwellings.

Trees reduce the energy use for heating and cooling buildings by serving as windbreaks and by providing shade. Sizable woodlands reduce air temperatures and thus may reduce air-conditioning needs in summer, but this saving may be more than offset in increased heat requirements in winter.

Trees for Windbreaks

Tree windbreaks reduce energy loss partly by reducing heat convection from the exterior surfaces of buildings: that is, windbreaks reduce wind speed and thus retard the replacement of warm air by cold. An estimate of the heat loss in winter for houses in one development in New Jersey indicated that, on the average, one-third of the loss was by conduction through exterior walls. Much of this conducted heat was lost to outside air by convection--which windbreaks can reduce.

Windbreaks probably are even more important for reducing infiltration-heat losses in houses than for reducing convective-heat losses. The infiltration of cold, outside air accounted for roughly one-third of the heat loss from the New Jersey houses. Usually most infiltration is wind-induced, although large temperature differences between the interior air of a house and the outside air also cause air infiltration.

While windbreaks and shelterbelts have long been used for farmstead protection in the Plains states, recent studies have shown that windbreaks are also effective for other parts of the country, including the highly populated Northeast. In New Jersey, a single row of conifer trees was found to have the potential to reduce air infiltration by as much as 40 percent. The reduced infiltration resulted in a 12 or 13 percent reduction in winter fuel use when winds were such that the trees protected an otherwise exposed house.

At The Pennsylvania State University, the effect of shade and wind reduction on space heating for a camper-trailer in winter was studied. The results are directly applicable to the 3 percent of American household that occupy mobile homes. It was estimated that, with a good shelterbelt, the energy savings would be about 8 percent for the heating season in Pennsylvania. For the windier climate of the Great Plains, shelterbelts would have produced heat-energy savings of about 20 percent for a winter season. The trailer was relatively air-tight; when windows were opened slightly to simulate a loosely constructed house, the relative effectiven of the wind shelter increased.

An optimum distance between a windbreak and a house is approximately twice tree height. A conifer windbreak that is two rows wide is nearly optimum for efficiency, and additional rows do not significantly increase its effectiveness. Trees close to the lee side of the house help to reduce air infiltration when used in conjunction with upwind shelters.

Trees for Shade

There is less quantitative information on how trees affect the costs air conditioning. In Alabama in 1973, mobile homes located in tree shade had power bills from $45 to $100 per year less than those without shade. The shade did not have to be complete for good results. If a roof avera 20 percent or more shade for the entire day, lower air-conditioning cost were noted. It has been estimated that energy for air-conditioning a trailer in Pennsylvania can be reduced 75 percent by a deciduous forest.

Tree shade decidely affects the external surface temperatures of buildings. Temperature differences of $9^{o}C$ ($16^{o}F$) between shaded and unshaded surfaces of wood-sided houses are common in New Jersey in June. This temperature difference can be equated to an instantaneous 60 percent increase in insulation of a house wall if the house is air-conditioned on a hot summer day.

By providing shade, trees have the potential to reduce large percentages of the energy required to air-condition small buildings. Moreover, the number of buildings that could benefit from shade is probably greater than the number that would benefit from windbreaks. Most small buildings are situated so that trees may grow nearby for shade; whereas, many buildings are at least partially protected from wind by other nearby buildings. However, on a national level, we do not know whether the shade or windbreak effect of trees is more important, because the energy demand for space heating is much greater than that for air conditioning.

It is convenient that deciduous trees, which are generally best for shading, lose their leaves in winter and allow the passage of considerable solar radiation that provides heat in winter--even though the trees absorb a signigicant amount of solar radiation. In temperate climates, the maximum year-round benefit from deciduous trees would probably be achieved by trees planted to allow a relatively unobstructed penetration of winter sun during 1 or 2 hours at midday. Coniferous shade, on the other hand, is particularly disadvantageous during the winter season, and conifers should not be planted near the south side of houses.

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TREES AND WOODLANDS REDUCE AIR POLLUTION

Leon S. Dochinger, Keith F. Jensen, and Roy Patton
Northeastern Forest Experiment Station
Delaware, Ohio 43015

Airborne wastes that result from the generation of energy combined with the emissions from natural sources would be intolerable to all forms of life if biological sinks were not continuously cleansing the atmospheri environment.

Water, soil, and vegetation are the primary sinks fom air pollutants. Trees are the dominant terrestrial sinks in the temperate regions of the world. They are effective because of their size, the high surface-to-volu ratio of foliage, and the frequently hairy or rough surfaces of leaves, twigs, and bark.

In recent years many investigators have examined the specific potential of plants to reduce aerial contamination. Much of the work has been with gaseous pollutants and herbaceous crops. Some evidence has been obtained to support the belief that plants do remove particulate and ga eous pollutants from the atmosphere.

Basically, particles are deposited on vegetation by three processes: sedimentation due to gravity, impaction due to aerodynamics, and deposition due to precipitation. After the particles are collected by trees, they may be absorbed or washed to the ground by precipitation. In time, the vegetative surfaces again renew their capabilities for trapping additional particulate matter. One author estimated that the retention of airborne materials ranged from 17 to 57 percent in pine stands and 82 to 86 percent in hardwood forests. Dust and heavy metals are such airborne materials.

The primary way that trees remove gaseous compounds from the atmosphere is by uptake through the stomates. Associated means may include uptake by plant surface microbes and through bark pores, and adsorption of gases to the surfaces of plant parts. The extent to which trees remove gaseous compounds is still debated. Some authors believe they provide substantial cleansing; others think they provide little.

Trees selected to provide the amenity function of cleansing must withstand the adverse influences of air pollution. Obviously, if the tree is severely injured or killed by aerial toxicants, its ability to function as a sink will be curtailed. In addition to tolerence to air pollutants, tree varieties should be capable of withstanding other urban stresses such as nutrient deficiencies, drought, and microclimatic extremes.

Woodland plantings cannot completely solve the problem of air pollution, but they may contribute substantially. Forests, and even small parks and expressway tree plantings, may be vital as air-purifying agents. They may decrease the aerial load of dust through the filtering effect of their foliage and needles, and may detoxify the dirty air resulting from injurious industrial wastes, which will help supply a greater volume of cleaner air.

Studies should be initiated to determine the magnitude of the effects of ambient pollution on trees and to learn which woody plants perform most effectively in filtering and diluting aerial pollutants. Tolerant tree species offer considerable hope for improving air quality when used as screen or greenbelts along highways and also in adverse urban situations. Research that leads to the selection of the most suitable species would facilitate private, institutional, and government agencies in planning programs for air-pollution control.

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TREES MODIFY NOISE LEVELS

Lee P. Herrington

College of Environmental Science and Forestry
State University of New York, Syracuse 13210

Many people consider most sounds in the urban environment unwanted, and while surface barriers to noise are limited in effectiveness, vegetation -- particularly trees and shrubs -- can make the acoustic environment less disturbing and disruptive.

Noise in General

Acoustic energy is generated by a source, is transmitted through some medium over a transmission path, and is received by a receiver. In all acoustic problems, these three elements must be examined. The source is characterized by its Sound Pressure Level (SPL), usually measured in decibels (dB) by the tonal composition of the noise and by the variation of SPL in time. Many scales for measuring noise have been devised. Of these scales, the A weighted measure of SPL (written as dBA) is becoming more and more common as a measure of environmental noise. For this measure, the weighting of the tonal composition of the noise is similar to that of the human ear.

Noise is transported mainly in the atmosphere. The wave front of acoustic energy spreads spherically from a point source such as a lawn mover or factory. The SPL from such a source is reduced by 6 dB for each doubling of distance covered. From line sources, as highways, the reduction is only 3 dB because of the cylindrical spreading of the wave front.

Although the solution to noise problems lies in removing the source, the urban forest can play a role by increasing losses in the transmission path. Additional reductions of noise, over and above those due to spreading the wave front, result from air and surface absorption, reflection, refraction, diffraction, and scattering of sound waves; these are called excess attenuation. Scattering and diffraction due to atmospheric turbulence are only significant in special circumstances. Refraction of sound waves is caused by temperature and wind profiles. During the day when the low layers of the atmosphere are warmest, sound is refracted upward because its speed is higher in warm surface layers than in the cooler layers above. At night, when cold air is at the surface, sound waves are refracted downward. Because wind speed usually increases with height, sound waves are refracted downward downwind of the source, upward upwind. Interacting effects of wind and temperature make predicting sound transmission complex. Adsorption in air is only important over long distances. Most excess attenuation is due to ground absorption.

The receiver may be a person. The person's reaction to a given noise will depend on expectations, activity, and psychological state. In general, people want quiet during evening hours -- just at the time when the atmosphere is most conductive. Visability of the noise source is also an important variable.

Noise Barriers

Groups of trees and other masses, such as berms and buildings, can serve as barriers. These are most effective when they are near the source or the receiver. Under daytime conditions, windbreaks provide reductions of 5 to 8 dBA in traffic noise. Berms 12 feet high, when combined with wide belts of trees, can reduce truck noise by 10 to 15 dBA. There is no data of which I am aware that describe the effectiveness of windbreaks or berms at night. However, experience and theory indicate that when the surfac air is cool (inversions) the noise will be refracted over any barrier. Therefore barriers can be expected to be less effective at night than during the day.

As urbanization increases, the amount of vegetation decreases and the amount of smooth, hard surface increases. The manner in which noise is affected by surface also changes. In city streets, the reduction in noise level for each doubling of distance is estimated to be 7 to 8 dB. Rows of buildings have been shown to reduce SPL by 15 to 20 dB.

With increased urbanization, the amount of "background" noise increases and individual sources of noise become less intrusive. Background noise is described as sound with an undefinable source. In urban areas this noise is mainly due to transportation. Since background noise "carries from all directions," barriers are of little use.

The average community reaction to noise has been estimated, and several guidelines on the effects of traffic and other noise on the public are available.

Research has shown that noise propagating through the forest can be reduced by 4 to 8 dB per 100 feet of forest cover. However, few houses or buildings are built beneath the forest canopy, and the creation of holes in the canopy allows noise to be refracted into the hole from above the forest canopy. But where a continuous forest cover exists -- as in parks or playgrounds -- the reduction in noise level is significant.

Noise is not absorbed by trees. It is scattered. But do not underestimate the psychological effectivess of trees. If the noise source can not be seen, then it is usually not considered as noisy as one that can be seen.

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TREES INCREASE RESIDENTIAL PROPERTY VALUES

Brian R. Payne

Northeastern Forest Experiment Station
Amherst, Mass. 01003

Trees can contribute substantially to the monetary value of residential property. This is true for unimproved land as well as for real estate that includes houses. Research studies have shown that trees on land suitable for residential development may contribute as much as 25 percent to land values. And houses on well-treed lots may sell from 6 to 12 percent more than identical houses on lots without trees. Thus, trees may be worth several thousand dollars per house lot.

These evaluations are supported by comparisons of actual selling prices for properties with and without trees, as well as by estimates of selling prices made by realtors and homeowners who compared photographs of similar houses on lots with differing numbers of trees. One study showed that the value of ½-acre lots with houses reached a maximum with about 30 trees. Adding more trees lowered property values, perhaps because the property appeared overcrowed or too shaded. Small trees, those less t.an 6 inches in diameter, did not seem to contribute anything to property values -- apparently they were too easily overlooked when value estimates were made.

The value of trees around houses is usually much greater than the cost of protecting them during building construction. To save trees, it may cost a builder from $200 to $2,500 per lot for the extra costs entailed by more careful work on the site. The amount varies with the number and location of trees to be saved, location of utilities, steepness of slope, and other site characteristics. In most cases these extra costs will be returned in the higher selling price of the property with trees.

It is vitally important, though, that the trees left during construction are sufficiently protected so that they remain healthy. Trees that are not windfirm should not be left near houses. If trees die or blow down after the owner has moved in, he suffers two or three losses: the premium that he paid for the trees, the cost of removing dead trees, and possibly the cost of repairing damage to his house.

Not all of the effects of trees are positive. Sidewalks cracked or sewer lines clogged by roots, leaves to rake, winter shade, and the risk od damage from falling branches or trunks are examples of the negative aspects of having trees around houses. But for most people, the benefits of trees for beauty, shade, wildlife habitat, or a place for children to play outweigh any negative aspects. Property values measure the net contribution of trees -- the average of positive and negative effects; this net contribution usually appears to be positive.

The positive monetary value of trees has several implications. First, builders probably should refrain from completely clearing land for housing developments; they should retain as many trees as possible. Second, builders probably can afford to employ tree specialists to help them save the right trees in the best locations. Third, homeowners probably can afford to spend substantial amounts to protect trees from damage or loss from insects, disease, or other causes; in doing so, they will help preserve their property values. Fourth, homeowners can increase their enjoyment of their property by planting ornamentals or shade trees, while at the same time recouping a portion of their planting cost through the eventual increase in their property value. Finally, foresters, arborists, nursery owners, and other tree specialists should recognize that their services and their products have high values in residential neighborhoods. In this situation, urban forestry offers economic as well as environmental benefits.

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HEATING VALUES OF FUELWOOD BY SPECIES

Clyde M. Hunt

Northeastern Area, State and Private Forestry
U. S. Forest Service, Broomall, Pa. 19008

Heat produced by fuelwood depends on its content of cellulose, resins, and water. Fuelwood improves in heat value as it dries, so fuelwood cut ahead and air-dried is recommended -- especially since burning green or wet wood increases the production of wood tars and extracts that may be deposited in the flue and can lead to chimney fires.

Pound for pound of wood, different species produce about the same amount of heat, but heat production per unit volume varies greatly among species. Softwoods are usually lower in density than hardwoods, which makes them easier to ignite, and more resinous, which makes them burn vigorously with a hot flame. But they do not produce the long-lasting coals of many hardwoods, so they are better used in spring or fall than in winter when long-lasting fires are needed. Softwoods are also a boon for quick warming fires, or for short fires that burn out before bedtime.

For long-lasting fires, some softwoods might be used in combination with heavy hardwoods such as ash, birch, beech, maple, and oak. Dry oak, hickory, and dogwood produce uniform, short flames and steady, glowing coals.

Certain woods, such as apple and cherry, beech, hickory, and pecan, are aromatic, and yield a pleasant smoky fragrance. Wood from fruit and nut trees often sells for more per cord than some woods with greater heating values, but by adding some of this kind of wood to the fire an aroma pleasing to many people can be obtained.

When wood is compared to fossil fuels, a cord of dry hickory wood, which weights about 2 tons, has about the same heating value as 1 ton of hard coal or 200 gallons of fuel oil. Hence, heavy hardwoods have about one-half the heating value of hard coal and one-third of that of fuel oil. Less dense woods have lower heating values per cord.

Heating values of a number of common woods are given in the following tabulation. Densities shown are those compared to water. Heat values are based on that of hickory -- set at 100. Woods near the top of the list burn longer, but those near the bottom ignite and burn quickly.

Species	Density	Heat valu
Osage-orange	0.78-.83	112
Dogwood	0.70-.79	100-107
Hophornbeam	0.70-.75	100-101
Hickory	0.70-.74	100
Oak	0.60-.73	86-99
Black locust	0.69-.70	95-98
Hornbeam	0.65-.71	93-96
Beech	0.64-.66	89-91
Hard maple (sugar maple and Norway maple)	0.58-.65	83-88
Birch	0.55-.64	79-86
Mulberry	0.59-.63	84-85
Apple	0.58-.62	83-84
Ash	0.57-.61	81-82
Southern pine (loblolly, longleaf, pitch, etc.)	0.51-.60	73-81
Elm	0.50-.59	71-80
Walnut	0.52-.55	74
Soft maple (red and silver maple)	0.47-.54	67-73
Tamarack	0.49-.53	70-72
Cherry	0.50-.52	70-71
Sycamore and London planetree	0.49-.52	70
Gum (sweetgum and blackgum)	0.48-.52	69-70
Mimosa or silktree	0.46-.50	65-67
Douglas-fir	0.45-.51	64-69
Sassafras	0.44-.46	62-63
Chestnut	0.42-.44	59-60
Spruce	0.41-.44	59
Tuliptree or yellow-poplar	0.40-.42	57
Hemlock	0.40-.42	57
Boxelder	0.40-.42	57
Cottonwood	0.38-.41	54-55
Balsam fir	0.36-.40	51-54
Redwood	0.33-.40	47-54
Aspen	0.37-.39	53
Basswood	0.37-.39	53
White pine	0.35-.37	50
Ginkgo	0.33-.36	47-49
Willow	0.30-.35	43-47
Horsechestnut	0.30-.35	43-47
Ailanthus or tree-of-Heaven	0.28-.33	40-45
Paulownia or princess-tree	0.25-.29	36-39

Cautions

Heat safely. Be certain the damper is open and the flue unobstructed before lighting fires. Use a screen in front of the fireplace to stop sparks from flying into the room. Have good ventilation so the fireplace will not smoke and cause irritation to eyes and nose. Have a fire extinguisher handy, and keep combustibles at a distance from the fireplace. Never use flammable liquids to light a fire indoors. If the house is air-tight, a vent may need to be installed to let in sufficient air to replace loss up the chimney, and to dissipate any carbon monoxide that may be produced when wood is burned with insufficient oxygen.

Never burn materials that may produce dangerous fumes or smoke -- plastics, poison ivy, or chemically treated woods (discarded poles and railroad ties).

Burn certain resinous woods with caution. Hemlock, larch, spruce, cedar, and juniper are among the species that contain moisture pockets in their wood. When heated, trapped gases and water vapor produce enough pressure so the pockets "pop" and shower sparks. Drying such woods helps reduce their moisture content, but they may be burned more safely in stoves than in fireplaces.

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ESTIMATING AND USING URBAN WOOD WASTE

Edward A. Lempicki

New Jersey Bureau of Forestry
Trenton, N.J. 08625

Sources of urban wood waste are both numerous and varied, so finding ways to use the waste can be quite a complex problem. This paper deals only with waste from the secondary processing of wood: locating the manufacturers, estimating their volumes of waste, and marketing the wastes.

Locating Manufacturers

Companies that use lumber to manufacture wood products often locate in or near urban areas because they are near a large labor supply, they are accessible for receiving and shipping materials, and they are near markets for their products. Consequently, the secondary processors of wood are concentrated, as are their wood wastes.

To locate and identify these wastes, you must first locate the manufacturers. If no directories of these processors are available, one must be made. In most states, the sources of information for such a directory include the Lumbermans National Redbook service, Dun and Bradstreet listing , and State industrial directories. Companies that make similar products will usually create similar residues, so the lists should be broken down by products -- (1) architectural millwork, (2) art and engineering supplies, (3) boats and boat accessories, (4) containers, (5) cabinets, (6) fencing, (7) furniture, (8) millwork, (9) music-trade items, (10) partitions and panels, (11) patterns and molds, (12) picture frames, (13) sporting goods, (14) toys, (15) trusses, and (16) miscellaneous.

A questionnaire can be used to update listings and gather more detailed information. It might include requests for information on (1) type of raw material used -- such as lumber, bolts, plywood; (2) species of wood and amount used annually; (3) products manufactured; (4) estimated amount of wood residue and the percentage used at the plant; and (5) the difficulty of disposing of wood residues.

After an inventory of manufacturers is completed, the location of each company should be pinpointed on a State map for an overall view of the workload on possible assistance.

Estimating Residue Volumes

Residues from the secondary manufacture of wood products fall into two broad categories: (1) dimensional waste such as rippings, cutoffs and rejects; (2) fine materials such as sawdust, shavings, and chips.

The amount of waste produced depends on the product being manufactured, the volume and quality of raw material used, and the efficiency of production. The range in amount of waste can be wide: from less than 5 percent to more than 50 percent of the raw material. In the manufacture of floor trusses, the waste might be about 5 percent of the volume of raw material, but 50 percent for wood shoe heels.

The only accurate way to obtain volume of residue is by measurement, but most companies know the volume produced over a period of time in general terms -- by hopper, container, or truckload. However, volumes of dimensional waste and of wood fines must be estimated separately because the available markets are usually different. Even within a residue category, a particular type may be more marketable than others: for example, pieces of 2 x 4 lumber 12 inches and longer or pine shavings may be more marketable than sawdust.

Markets for Residues

A particular residue must not only fit a specific use, but be produced in sufficient quantity to allow marketing on an economically sound basis. Hence, available markets must be investigated as thoroughly as the producers -- information is needed on material specifications, volume requirements, and the buyer's shipping, receiving, and storing facilities.

While markets for residues are as numerous and varied as the producer the major markets for dimensionsl waste include the shipping industry (for storing and bracing), other secondary processors, landscapers and nurserym (for stakes); and for fine materials, the residue dealers and companies that use wood fines in a variety of products:

Chips and hogged material -- for mulch, soil or slope stabilization, chemical filters, pulp and paper products, sludge composting, animal bedding, charcoal additive, particle board and hardboard, and fuel.

Shavings -- for particle board, animal bedding, poultry litter, industrial fuel, briquettes, cement products such as lightweight decking for roofs, insulation, packing material for various items including nursery stock.

Dry sawdust -- for animal bedding and poultry litter, meat smoking, saturating felt, briquettes, industrial fuel, floor sawdust (for markets and taverns), sweeping and rug cleaning compounds, abrasive hand soaps, fur processing, porous brick and tile, molded articles, composition floors, plaster and insulating boards, packing and stuffing, insulation, certain rubber compounds, and oil-drilling muds.

Wood flour (manufactured from other residues) -- for plastics, linoleum, molded products, adhesives, plastic wood, dynamite, flares and fireworks, rubber compounds, flooring felt, and foundry molds.

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SALVAGING TREES FOR SPECIALTY PRODUCTS

Edward A. Lempicki

New Jersey Bureau of Forestry
Trenton, N.J. 08625

Shade trees along city streets and state highways, and those near suburban homes, may reach a large size and have butt logs suitable for some specialty products. However, when these trees are felled, they are all too often used only for fuelwood or wood chips, or hauled to landfills.

Urban foresters can stimulate better use of such trees, and eliminate landfill problems, if they encourage integrated operations like those of a large arborist firm in central New Jersey. This firm, with about 40 employees, created so much waste from its tree removals that its landfill charges were about $20,000 a year. The firm eliminated these costs by salvaging the trees and producing specialty products with their own sawmill, dry kiln, and some special machines such as a metal detector and stake sharpener. Although the firm buys the stumpage in an occasiona woodlot, 95 percent of its wood products come from the removal of dead or hazardous shade trees.

A wide variety of species is processed at one time, which creates both problems and advantages. There may be logs from white ash, beech, catalpa, black cherry, Kentucky coffeetree, American and English elms, red, sugar, and Norway maples, several species of oak, certain pines and hemlock, sycamore, sweetgum, black and English walnuts, etc. The different species of wood may require somewhat different handling in drying for quality material, and an effort is made to meet these requirements. However, the variety of species meets the need of, and arouses the interest of, many buyers who make their own furniture.

First, the metal detector is used on all logs, then how the butt logs will be used is determined by their species and quality. Select grades of dimension lumber are sawn from high-quality logs and, after air and kiln-drying, sold for manufacturing classical furniture. Many of the butt logs are better suited for free-form furniture. After sawing, stickers are placed between pieces, covers are placed over the pile of free-form pieces from one log, ends are waxed to prevent checking, and the pieces are air-dried for 2 or 3 months before they are kiln-dried. Quality dimension material is similarly handled.

Low-grade material may be sawn into stakes and pointed, then sold to engineers, arborists, or nurserymen. Other low-grade material is sold as fuelwood, which is usually delivered by the truckload. Shavings and sawdust also have a ready market. In the New Jersey operation, branches are chipped, and the chips are sold without going to the mill yard.

UTILIZATION OF WOOD FROM STREET TREES

Richard F. Watt

Northeastern Area, State and Private Forestry
U.S. Forest Service, Broomall, Pa. 19008

Millions of trees grow along our streets, in parks, and near residences, and they produce a tremendous but unknown quantity of wood fiber. This material is often disposed of as waste at considerable cost to the community and landowners in time, money, and increasingly scarce landfill space. Much of the wood is produced during routine tree work, such as trimming and removal. Catastrophic losses due to wind, storms, ice damage, disease, or insect injury, produce large volumes of brush and wood in a short period that tax the community's facilities for removal, and emphasizes the problems of disposal even to the casual observer.

Landclearing for houses, highways, and industrial developments also produces large quantities of wood that are too often wasted. Unlike most of the logs that are produced from street trees, many quality logs could be harvested in landclearing operations. These operations are often planned several years in advance so that developers can sell the stumpage and obtain additional income. However, in many large developments, this wood may be piled and burned, even though there is an increasing market among homeowners for firewood.

Unlike much of the wood that is used for industrial wood products, street tree wood is close to the ultimate consumer and readily accessible by truck on all-weather roads; however, the low quality of the wood makes it difficult to process. Metal objects and cement, overgrown by the trees and difficult to detect, are a hazard to woodworking equipment and cause costly damage to saws and knives. Boles are short and of low quality because of wounds, stain, and decay. A high percentage of the total tree volume is found in the large branches typical of open-grown trees. The intrinsic quality of the wood from species such as elm, silver maple, box elder, gingko, catalpa, and other ornamentals, is low. Some diseased wood requires prompt destruction or other treatment, which complicates industrial use.

In a time of increasing interest in recycling waste, the obvious failure to recycle urban tree waste is unfortunate. But many communities do demonstrate that some type of use, however low the value of the product, is preferable to the costs incurred for the equipment, time, fuel, and labor required to dump this material in a sanitary landfill.

Perhaps the most common use of tree waste is for wood chips. Portabl chippers reduce brush, branches, and small boles to chips, which are blown into a truck; this reduces the volume considerably. Wood chips are used widely to mulch landscaping, to protect exposed soils from erosion, and to discourage weed growth. Decomposition in place adds organic compounds and mineral elements to the soil. City parks may use chips to surface rustic walking paths, bridle paths, and playgrounds. Homeowners often make a considerable effort to pick up chips at a known dumping ground. A limite market for chips does exist in a few localities for the manufacture of roofing felt.

Chips can also be used in power plants to supplement coal or to provide the primary fuel for boilers. Several large cities use chips exclusively or in combination with other city refuse to produce steam for heating or to generate electricity. As the cost of conventional fossil fuels continues to rise, burning tree waste and other organic waste produced by households and industry will become an increasingly attractiv option.

Many of our larger cities find that the disposal of great volumes of sewerage produced by treatment plants poses a problem of increasing costs. Composting sludge for use as an organic soil amendment is one solution. Coarse wood chip mixed with sewerage provides better aeration of the sludge during composting, which eliminates the strong odors associated with the anaerobic decomposition. The breaking down of the wood chips tends to bind the heavy metals in sewerage sludge, which makes a more acceptable product for spreading on gardens and farmland. So composting provides an outlet for two products that are otherwise difficult to dispose of. Such material generally has to be used on municipal property, given away to potential users, or sold at a low price -- but this is still a better solution than burial in landfills or dumping at sea, alternatives that are being restricted by environmental regulations.

Formerly, a common rite of the suburban landowner was burning leaves in the fall. This is now outlawed in most areas by ordinances against open burning. Wood chips can be used to compost leaves, which helps provide aeration for leaves that normally mat into a dense mass when moist -- this also raises the organic content of soils to which it is applied.

With the increasing use of fireplaces and stoves for residential heating, many communities report that wood of burnable size left at the point of production along the streets is soon picked up. In fact, competition is often keen for this material. Some larger cities announce a central location for dumping potential firewood, and are very successful in disposing of it with no cost other than trucking it to the site. A few cities sell wood, but this necessitates additional labor to collect small fees.

Sawlogs are a small component of the total volume, but small sawmills can sometimes process logs for speciality items for home woodworkers interested in unusual forms and grains. Diagonal sections can be cut from relatively short boles and larger branches for use as small tabletops, clock faces, and similar items. With care and the use of metal detectors, some small mills have been able to convert logs into low-quality lumber for blocking and pallet stock. But many mills have failed because of the excessive damage to equipment from undetected iron in logs. Clearly, sawing urban tree logs successfully is a highly specialized business that requires special skills, raw materials, and markets to be profitable.

The volume that might be produced from wood waste has not been estimated by most cities because of the low value of the product when weighed against the cost of making such estimates. But for any industrial use, a reliable and steady source of wood volume is needed to plan operatio Current volume tables used by foresters are based on the production of certain portions of the bole of trees that have been grown in forest stands Many tables for the volume of cordwood end at 4 inches minimum diameter; little or no consideration is given to the considerable volumes of wood found in the branches and tops. Urban tree waste is composed primarily of such branches and tops that are an unknown quantity in open-grown trees. But with increasing interest in the energy potential of total biomass produced by the forest, the techniques and the volume tables for the whole-tree utilization of urban trees should soon be available.

An adequate tree inventory and long-term management plans will help in estimating long-term wood production in a city. Species and sizes should be included in these estimates if they are to be useful to potential buyers. Long-term management of urban trees must include scheduled removal and replanting of trees, which is the basis of the rotation length and cutting cycle found in sustained-yield management of the rural forest. At present, most urban trees are not removed until they become a hazard through internal rot, or are dead; long-term planning should establish a rotation age for various species beyond which esthetic value and potential use of wood fiber begins to decline.

Municipalities and private contractors now have the equipment necessary to break down tree waste into pieces that can be handled by primary users. Chain saws quickly reduce firewood material to chunks that can be loaded and transported by local residents and commercial sellers. Smaller diameter branches can be quickly chipped, blown into trucks, and moved to composting areas, boiler plants, or dumping grounds for pickup by individual users. Some communities have a central area where wood is brought for separation by size and quality; often private arborists will also be allowed to bring their refuse. Sometimes a large chipper or Destructor that breaks down bolts too large for a portable chipper and a small sawmill may be available. In some centers the potential sawlogs will be stockpiled for sale to private sawmillers. An incinerator may be available for burning -- the last resort when other use of wood is not feasible.

The public's awareness of the use of waste wood is important in any community tree program. The opposition to the removal of decadent trees may be lessened if it can be pointed out that the material will be used, particularly for recycling as mulch and compost for city property. It serves to remind the city dweller that even in the urban forest there is a natural cycle of death, replacement, and recycling somewhat similar to that in the wild rural forest. Many European cities have considerable forested areas that serve a truly multiple use for wood production, recreation, watersheds, and wildlife. Our urban trees, even those along streets, can serve many similar purposes if we consciously plan for long-term management rather than merely react to each crisis.

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EFFECTS OF UNFAVORABLE SOIL CONDITIONS ON URBAN TREES

Johnson Parker

Northeastern Forest Experiment Station
Hamden, Conn. 06514

There are a number of abnormal soil conditions that can lead to tree damage. Very often the effects do not seem related to anything in the soil, but closer examination usually reveals a soil problem that can be corrected.

Soil Compaction

When a soil is subjected to frequent trampling or compression, as on picnic sites and park areas, the soil pore space and especially the air capacity of that pore space are decreased. For example, air capacity of a sandy soil in an unused forested area may average 40 percent of the total soil volume, but that in a used or trampled site may be only 28 percent. In a sandy loam, air capacity in an unused area may be 38 percent and in a used area 20 percent. At the same time, the amount of pore space occupi by water seems to change relatively little. Field capacity may, in some cases, increase somewhat, but the rate of water infiltration can be greatly reduced to about one-sixth of that in sandy soils of unused areas and even more so in loams and sandy loams. Permeability can be reduced to only 1/20 of that in unused areas. As a result, roots have greater difficulty penetrating the soil. With reduced air space, roots are also subjected to poorer aeration and the buildup of carbon dioxide.

It is popularly thought that waterlogged roots are injured due to a lack of oxygen, but experiments have shown that in most cases an excess of carbon dioxide -- partly produced by the living roots -- is the more usual cause. Also, certain bog acids such as tannic acids may form in poorly aerated soils, and can injure roots. Obviously, drainage is a solution to the problem, either by ditching or installing tile pipes. And the application of limestone to the soil can help counteract bog acids.

Landfill Gases

The practice of dumping trash, garbage, and industrial waste into landfill areas then covering it with soil has greatly increased since new laws have prevented burning. The usual requirement is that the final soil cover by 2 feet thick, but in practice it is often much less. The waste underneath generates toxic and explosive gases, such as methane and ethane, as a result of anaerobic (airless) microbial decomposition. Water that seeps through the landfill area may also become polluted, and this can result in damage to adjacent vegetation, as well as to trees and shrubs that are usually planted in this top soil.

Besides combustible gases, high levels of carbon dioxide and low levels of oxygen have been found in the soil of landfills. Other gases present in lesser amounts may be ammonia, hydrogen sulfide, mercaptans, and ethylene; one or more of these can be directly toxic to trees. Tests made in such areas where trees are dying almost always reveal a correlation between concentrations of combustible gases or carbon dioxide and reduced tree growth. In landfills, oxygen commonly falls from about 21 percent to about one-half of that, and in some cases to zero. In contrast, carbon dioxide may be 21 percent of the total air in the soil, although normally it is near 6 percent.

In such areas, gas can be detected by: 1) thermal conductivity (catalytic combustible) gas meters, 2) oxygen gas meters, 3) carbon dioxide meters like the infrared gas analyzer, 4) observation of unusual settling or cracking of the ground, and 5) unpleasant odors. Vertical gas-venting pipes have been used with some success to reduce the amount of gases in such areas.

Gas Leaks

Ruptured gas mains are a common source of gas leaks. In recent years, the ruptures may be partly the result of an increased use of natural gas that causes pipe seals to dry out. Also, higher pressures are now used.

Trees subjected to gas leaks usually show the effects suddenly: leaves may turn yellow or brown and are shed. In some cases, the effect may be gradual if the gas leak is relatively small. The exact cause of gas injury has not been entirely clear until recent times. Manufactured gas was known to contain poisons like hydrogen cyanide, carbon monoxide, and ethylene, and these were frequently the cause of injury. But natural gas still killed trees, even though experimental exposure of plants to methane and ethane seemed to have little effect. It is now known that soil bacteria can oxidize the methane with the result that the soil oxygen is depleted, while carbon dioxide increases. Decreased oxygen or increased carbon dioxide can be damaging to tree roots, more so to some species than to others. In some cases, the smaller roots may turn bluish-black after long exposure to the gas. Cankers can also develop on trunks of trees where the soil is exposed to slow gas leaks.

Ground limestone, preferably mixed into the soil, may reduce the levels of carbon dioxide, and it seems to reduce the level of other gases accumulated in the soil air spaces. Charcoal, although expensive, would be much better for absorption or organic gases.

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EFFECTS OF AIR POLLUTION ON TREES

Leon S. Dochinger, Keith F. Jensen, and Roy Patton

Northeastern Forest Experiment Station
Delaware, Ohio 43015

In recent years, urban forests and trees have been threatened by ever increasing concentrations of air pollutants released by industrial plants, and by increasing urbanization. Many of these airborne compounds can be both beneficial and injurious to trees, either directly by affecting biomass processes at the cellular level or indirectly, by influencing biological and chemical activities in the plant community. Eventually, the response of woody vegetation to air pollution is a decrease in plant growth and yield at both the organism and community level.

Many air pollutants are toxic to urban trees. Economic estimates suggest that the primary offenders of woody vegetation are oxidants (ozone), fluorides, and sulfur dioxide. Oxides of nitrogen and oxides of sulfur also contribute to acid precipitation. The potential consequence of this precipitation on terrestrial and aquatic systems has caused worldwide concern.

Ambient concentrations of single and multiple air pollutants usually affect leaf tissues and the inherent related physiological and biochemical processes in leaves. Symptoms of foliar damage are the visible patterns of injury and they may be acute or chronic.

Acute symptoms result from toxic concentrations of pollutants over a short exposure time. Injury appears within 24 hours and is expressed as necrotic lesions, premature defoliation, and, possibly, tree mortality. Chronic systoms result from a sublethal dose of air pollution over an intermittent or continuous period of exposure. Injury is characterized by a chlorosis or similar disruptive pigmentation in leaf tissues, senesence of leaves, and biomass curtailment.

Air pollutants may also disrupt tree growth, productivity, and reproduction. Actual response to aerial phytotoxicants is affected by temperature and humidity, and the fertility, compaction, moisture content, and nutrient composition of the soil. Trees also condition their own response to air pollutants through genetic tolerance and physiological vigor.

The full consequences of the various biological repercussions of air pollutants are not known. Serious consideration must be given to developing realistic assessments and ecologically safe control measures to minimize the adverse effects of air pollution on urban tree plantings.

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EFFECTS OF HEAT, COLD, DROUGHT, WIND, AND SALT SPRAY ON URBAN TREES

Johnson Parker

Northeastern Forest Experiment Station
Hamden, Conn. 06514

Trees are profoundly affected by abnormal variations in the climate, including high or low temperatures, lack of rain, and storms that may be accompanied by high winds or wind-driven salt spray from the ocean.

Heat

The effects of heat on trees are most apparent in certain types of microclimates, such as locations adjacent to buildings or near blacktop pavements. Radiated and convected heat can damage leaves and sometimes the trunk and branches. Blacktop pavements continue to produce heat at night, either by radiation or convection, and can contribute to leaf dehydration -- leaves may be "scorched" or burned at the tips (conifers) or on the margins (broad-leaved trees), and eventually turn brown throughout. Bark of certain species of trees, such as beech which usually grows in shady locations, can suffer from sunscald, especially when trees are widely spaced. Small cracks form in areas of the bark, and this bark may die and form unsightly dead patches a few inches in diameter. These can develop into cankers which are associated with the presence of certain fungi or bacteria. Other species of trees like the thick-barked pines, e.g., southern pines, are generally resistant to sunscald, although their bark can dry out and become susceptible to attack by bark beetles.

Cold

Temperatures below the freezing point of water can affect trees adversely at any time of the year, although usually the damage occurs in spring when shoots have begun to grow. In red pines, for example, damage to new shoots is often mistaken for injury by pine shoot moth since the leaders turn brown, droop, and dry up. Exotic trees planted north of their natural range frequently suffer from cold injury. Such damage commonly appears as leaf browning or "tip burn" in conifers, or an marginal browning and yellowing of leaves of broad-leaved evergreens, and in failure of buds to elongate in the spring.

Most cases of winter injury related to cold can result, not from the cold alone, but from the failure of the shoot or xylem of the leaves themselves to conduct water. The effect has been called "frost drought." This is the common cause of browning or yellowing of conifer leaves in winter. Very often the effect is blamed on some soil problem. Burlap covers and windbreaks, as well as certain sprays that coat the leaf surface, may help to prevent such injury.

Roots are generally more sensitive to freezing in winter than tops, although temperatures do not usually fall as low in the soil as in the air above. Some species are injured when there is little snow cover or natural mulching to act as insulation. In the following spring, the above-ground parts may dry up and die with no other visible symptoms. Container-grown trees are especially susceptible to such damage.

In some urban areas where trees are exposed by wide spacing, it is fairly common that trunks crack as a result of a combination of winter cold and radiant warming. When trees are deeply frozen, warming one side of the tree by the sun's rays can result in severe distortions and rupture of the wood and outlying bark. Cracks can also appear on twigs, usually so small as not to be noticed. These are then invaded by fungi, such as the black knot fungus of black birch. Cold is not usually suspected as the cause.

Drought

"Drought" usually implies soil drought, but it may also be atmospheric drought, although the former is far more common. Effects of drought are sometimes obvious with some species like dogwood that wilt readily. Shallow-rooted shrubs also commonly wilt in forests when subjected to severe drought. Although most foresters and tree workers may not have observed distinct examples of the effect of natural drought on forest trees, they now have access to many published studies on the direct effects. Mineral absorption is sometimes interfered with, and trees may show signs of iron deficiency (yellowing of young leaves) or nitrogen deficiency (yellowing of all leaves). In more severe cases, dieback and early leaf-fall are common.

Drought can cause cracks in branches and trunks. Cracks may be several feet long, parallel to the direction of longitudinal growth. They may resemble frost crack, with which they are commonly confused. But drought crack is most common in summer, frost or cold in winter. Trees suffering from drought crack often grew under very moist conditions, and then were subjected to soil and atmospheric drought.

Another result of drought, which is much more subtle, is injury that may not be apparent at all. Trees subjected to drought undergo certain chemical changes that make them susceptible to attack by parasitic organisms as the shoestring root-rot fungus and the twolined chestnut borer. This is why it is important to water trees suffering from drought, if at all possible. When drought is combined with the effects of defoliation by various leaf-feeding insects, as often happens, the effects are even more pronounced, and subsequent invasion by parasites is even more likely. Application of fertilizers has been found beneficial for the recovery of defoliated trees. Under drought conditions, high-pressure injection of a diluted liquid fertilizer into the soil under the tree can be helpful.

Wind

The effects of wind on natural forests are most frequently observed in hilly or mountainous terrain or along waterfronts near oceans and lakes. (Salt spray may also play a role near oceans, but the effects are different from wind alone.) Wind may also cause damage along the edges of stands where adjacent trees have been felled. However, observations of hurricanes in New England suggest that such winds are freakish, and gusts of unusually high velocity can cause windthrow and breakage that seem unrelated to minor changes in topography or stand cutting practices. In winter, evergreen conifers obviously will be more affected by the force of the wind than leafless deciduous trees. For most species, windthrow and windbreak damage is most frequent in trees that are over 20 to 40 years old, although this depends on many other factors. When the soil is dry, windbreak is more common; on wet soils, windthrow.

When young trees are planted, deep soil preparation will allow deeper roots to form in subsequent years, thus providing greater stability. Ironically, when the generous use of NPK fertilizers leads to more rapid growth, trees are more susceptible to windbreak. Where the ratio of height to diameter at breast height is less than 60, a tree is more likely to survive severe wind storms. For example, a tree 30 feet tall and 1 foot in diameter would have a ratio of 30/1 and, therefore, more likely to survive bending than a tree 60 feet tall and 1 foot in diameter. When trees are grown with wide spacing, they are more likely to be short and have wide-spread branches. They are, therefore, more wind-resistant.

Salt Spray

Experiments have shown that salt spray is more damaging to roadside trees than soil-salt accumulation. The ability of leaves of woody plants to absorb salt and other mineral ions, like lead and cadmium, had long been known. We would therefore expect that naturally-coated waxy leaves would resist salt absorption. In an attempt to reduce salt absorption, antitranspirants ("antidesiccants") have been sprayed on leaves of roadside trees to coat them with a semiimpervious layer. The results have not been promising.

Along sea coasts, salt spray can be carried miles inland, a phenomenon often associated with flooding of lowland areas by the sea. Damage by sea-salt spray often results in yellowing the foliage of conifers, followed by progressive browning that starts at the leaf tips. On broad-leaved trees, the leaves usually turn brown and become crisp, an injury similar to that caused by late-spring frosts, with which it is likely to be confused. Dead leaves may persist on the tree for several weeks, but new leaves usually emerge from latent buds.

Salt-resistant shrubs and trees planted along roadsides partially solves the salt-spray problem common to urban areas. The use of mechanical barriers may also be of help.

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SHADE-TREE SELECTION

Richard F. Watt

Northeastern Area, State and Private Forestry
U. S. Forest Service, Broomall, Pa. 19008

Introduction

The selection of the proper species of tree to be planted is fundamental to the success of any shade-tree program, whether for a city or a homeowner. Once a tree is selected, purchased, and planted, considerable costs have already been incurred. If the tree is not suited to the site, it may not survive, resulting in a complete loss of the time and money used to plant it. If the tree survives, but was poorly selected, the community will have either a long-term asset or considerable expenses for its care.

The proper species or clone will provide the benefits desired for a long time--20 to 50 years--with a minimum of costs in pruning, spraying, fertilizing, watering, and final removal. Consequently, the initial costs may be secondary in relation to both the long-term costs and the benefits during the life of the tree.

Criteria for Selection

Horticulturists and nurserymen have developed a multitude of species and cultivars for use as shade trees. But there are basic considerations to be made regardless of where the tree will grow, or for what purpose.

First, the species should be adapted to the climate. A subtropical species obviously will not grow in our northern states. Horticultural manuals and nursery catalogs often provide a map of hardiness zones based on average minimum temperatures, and list the zones for available selections. More difficult to evaluate is the prevalence of ice storms, drought, spring frost, and other irregular weather conditions that may affect long-term survival. Observations of species that can be found growing under similar conditions (as in arboreta and nurseries, or local plantings of some age) are excellent indications of adaptibility to climate.

Second, the precise location of the planting should also be considered. Is the soil wet with a high water table, or is it sandy and excessively dry? Sometimes the one condition can be ameliorated by drainage and the other by adding soil, but often it is wiser to select a species that will be suited to the prevailing soil condition.

Third, the amount of space available for the growth of the tree should be determined. A tree that will grow to a large size is obviously not suited to a narrow lawn under a utility line. A consideration of underground space is also important. A deep-rooted tree should not be planted in a shallow manmade park over an underground garage. Trees, such as poplars, with roots that seek out sewer pipes should not be planted close to pipes. The roots of some species may cause considerable damage to sidewalks and curbs. Trees selected for a suburban park or large yard can frequently develop into magnificent mature specimens. On an urban street with a small plot surrounded by pavement, sidewalk, and nearby buildings, a small fastigiate tree is the logical selection. If plots are suitable for large trees near the street, species with strong central stems may be desirable where clearance for vehicles is required.

Fourth, the purpose of the tree is also an important consideration. Some trees are desired for light shade that will provide some comfort from glare, but also allows a lawn or flowering plants to thrive. Trees chosen to form a screen to hide an unpleasant view might well be an evergreen species, either coniferous or broadleaved. Deciduous trees may be chosen for heavy shade in the summer but an abundance of light in the winter. Showy flowering trees may be needed to brighten a drab landscape, and both spring- and summer-flowering species are available.

Fifth, possible damage to the tree by disease, insects, or injury is especially important to consider if the tree is to have a long life with minimum maintenance. Observations of older plantings during the growing season may be especially helpful, although catalogs may mention species and cultivars with known resistance to specific pests. Abiotic damage, such as air pollution, road salt, and natural-gas leaks, should also be considered. Of course, where these factors are most prevalent, few or no trees survive; but a number of species are more resistant than others. Also important are the form of the tree and its inherent strength. Many fast-growing species have weak wood that requires, at best, heavy clean-up problems after storms and, at worst, disrupts utility service and highway traffic. These species should be avoided, particularly since many of the stronger species will grow rapidly in a well-prepared site that is irrigated and fertilized as needed. Proper pruning of trees will eliminate weak crotches and other sources of structural weakness.

Species to avoid include those that produce considerable litter in the form of fruit or seed, leaf and bark shedding, and loss of small twigs. Male or sterile clones are available for a number of species that are otherwise troublesome.

Quality planting stock should be selected in all cases. Choose a nurseryman known for his high standards rather than the one who is the low bidder. Mislabeled trees may not be noticed until they are well-established, or until undesirable characteristics appear as the trees mature. Planting stock from a good supplier will be pruned to an acceptable height for street or park planting, and it will be carefully lifted and protected from damage during transportation.

Street trees may have to meet local requirements such as those suggested by the International Society of Arboriculture in their publication on standard ordinances.

Sources of Information

Local publications on suitable species are available from the horticulture departments of many State agricultural colleges, from arboreta and arborists associations, from horticulture societies, and sometimes from utility companies. Texts on horticulture and arboriculture give additional information. A compilation from nursery catalogs will indicate the species that are commercially available.

The wide variation in climate across the country makes it impractica to assemble a list of suitable species here. This is best done by the reader for his particular location, supplemented by his personal observations of plantings in situations similar to his sites. If the planting program has sufficient lead time, a municipality can contract with nurseries for deliveries of species that are highly desirable but not usually available.

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FLOODPLAIN LIMITATIONS ON FOREST USES

Kenneth J. Johnson

Northeastern Area, State and Private Forestry
U. S. Forest Service, Portsmouth, N.H. 03801

Floodplains and Use Restrictions

The floodplains of rivers and streams are drainage channels formed by nature for flood flows resulting from heavy snowmelt or rainfall. In nature there are floods, but no flood problems. Urban flood problems began with the construction of structures below flood heights. As developments expanded over the floodplain without regard to the effects on flood flows, the economic losses multiplied. Communities are now subject to multiple floodplain regulations that restrict construction and development within the flooding zone. In some instances, these limitations may preclude traditional forestry activities.

Measures to prevent flood damage and its impact include flood-contro zoning ordinances, subdivision ordinances, buildings and sanitary codes, open-space acquisition programs, flood-warning systems, flood insurance, and pu'lic policy that discourages the extension of streets and water and sewer lines into flood-prone areas. Some of the legal measures impos limitations on land use, including urban-forestry activities.

The legal floodplain limits are commonly defined in terms of flood frequency. Flood-frequency analysis, based on past records, is used to predict the frequency that a flood of certain magnitude will be equaled or exceeded. Some boundaries used in floodplain regulations are based on the 100-year flood. This means that in any one year there is a 1 percent probability that a flood of this magnitude could occur. Flood-frequency analysis is also used to calculate the boundaries of a particular flood. States and communities use various flood frequencies to define floodplains, so there are inconsistencies in floodplain boundaries.

The U. S. Water Resources Council has published guidelines to encourage beneficial values of floodplains, such as agricultural and forestry uses. Within the floodplains, forestry practices must minimize the hazards of flooding and erosion.

Management Problems

The preservation of the natural storage capacity is probably the most important goal in designing forestry practices for flood zones. However, the urban forester or planner is also faced with the problem of meeting or exceeding water-quality standards.

Building and filling in the floodplain reduce flood-holding capacity. For example, a raised access road built in a floodplain may increase the height of flood crests above the road, hence add to the potential losses there.

The wetness of floodplain soils poses problems in choosing road locations and also limits the type of equipment that can be used for timber harvesting.

While floodplain soils are generally finer textured, wetter, and more fertile, they are also more variable than upland soils. The better drained soils have mostly been cleared for agriculture and other uses. Most floodplain forests now grow on poorly drained soils or on sites that are frequently and severely flooded. It is desirable to classify bottomland forests according to their productivity for particular uses.

Many floodplain forests form only a ribbon along streams, and generally they are not large enough to be managed as separate units and are best handled as part of the contiguous forest type. However, in the larger valleys, such forests warrant separate management.

Management Opportunities

The concept of an "environmental corridor" may be useful in planning activities on floodplains. Such a corridor is a linear management zone of vegetation that follows the natural drainage channel and includes the whole floodplain. Because of past regulations, these natural corridors remain in many of our larger urban areas. The corridors can link areas reserved for open space or parks, and, if suitable, also be used as bicycle paths and hiking trails, and for nature study, and other outdoor activities. Timber management should favor esthetically pleasing, fairly open stands, and species adapted to the site and use. In all areas, buffer strips should be maintained along all permanent streams, and limits should be set on the amount of slope or bank that may be disturbed.

There are many techniques for preserving floodplains where the public interest is served: tax incentives, scenic and preservation easements, and fee-simple acquisition. Conservation trusts or watershed associations may help in obtaining the land for town forests or other purposes.

Classification and Use Limitations

Floodplains can be classified according to soil conditions, topography, and dominant vegetation. For example, the work of Lawrence Morris [1/] and Alfred Molliter of the SUNY College of Forestry suggests that in portions of the Northeast there are five site conditions:

Site I is a poorly drained wetland resulting from frequent deposition of flood sediments. Forests are primarily willow, cottonwood, and silver maple. Wildlife management is the most suitable use.

Site II is on well-drained silts, which form the most productive bottomlands. In early succession, cottonwood and sycamore are dominant; in later stages, silver maple. Stands are not esthetically appealing and dense undergrowth, especially of stinging nettles and poison ivy, limits recreational use.

1/ Morris, Lawrence. Evaluation, classification, and management of the floodplain forest of south-central New York. M.S. thesis. SUNY, College of Environmental Science and Forestry, Syracuse. 1977.

Site III is frequently flooded, extremely unstable, and is on point bars of coarse-textured deposits or on first bottoms. Flood-tolerant species such as cottonwood, willow, and elm are most common. Sites have little recreational potential because of flooding, unstable soils, and stinging nettles.

Site IV is on an old, stable, point-bar deposit that supports mature hickory and silver maple forests. Nettles and the debris of frequently flooded sites are absent, and flooding is minor. Such areas are valuable recreational sites for camping or water-oriented activities.

Site V occupies terraces that may be flooded only occasionally and are near the upper edge of the 100-year flood probability. Forests are upland types with pine, oak, hickory, black cherry, and maple. These terraces are the least limited for use, and are esthetically attractive for recreation.

Other sites that may fall within a regulated floodplain are those that are not near a stream, but occupy poorly drained soils in headwater drainages. Soil wetness and high, although fluctuating, water tables limit us:. Soil compaction by vehicles or other means may slow drainage and cause tree mortality.

The silviculture of floodplain forests varies from area to area. Urban foresters should consult the local silviculturists and ecologists on the practices suitable to specific forests. Forest-soil specialists and hydrologists can also prescribe some of the management measures needed on local floodplains.

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FERTILIZATION OF TREES

Johnson Parker

Northeastern Forest Experiment Station
Hamden, Conn. 06514

Methods

In general, there are two ways to fertilize established trees. One is to apply dry fertilizer of the "NPK" type. Usually, holes are made in the ground about 1 to 2 feet deep and 1 to 5 inches in diameter either with a drill apparatus or a crowbar. Then the holes are filled with a general-purpose fertilizer such as an NPK 10-10-10--this means that there is about 10 percent of each nitrogen, phosphorus, and potassium, and the remaining bulk may be an inert substance like sand. Coarse sand can be beneficial to many types of soil like fine-grained silty or clayey soils. The bulk of the fertilizer may also be a relatively inert material like cottonseed meal or wheat chaff. Such organic material slowly decays and improves the structure and aeration of the soil. Usually, dry fertilizers are applied to the area starting just outside the drip-line (outer edge of the crown) and working inward to about 3 feet from the bole. Arborist' should realize that surface roots of most shade trees grow out much farther than the edge of the crown, sometimes to several times the diameter of the crown. But it is obviously impractical to try to cover such wide areas, so the procedure suggested above still holds.

Trees may also be fertilized with liquid fertilizer. This method makes use of water-soluble salts of nitrogen, potassium, and phosphorus. The nitrogen is sometimes in the form of urea. Solutions are made up with water, often at ratios of 3 pounds of NPK 16-32-16 to 50 gallons of water. Most arborists inject such solutions into the ground with pressure nozzles that penetrate about 3 feet. However, solutions can be poured on the surface or into holes. Liquid fertilizers are usually applied just inside the drip-line. If injections are made near the bole, the nozzle is likely to cause injury to large roots radiating out from the central root.

There are two other ways that fertilizers can be applied to trees. One is to spray a liquid fertilizer on the leaves. This is not as effective as applying fertilizers to the roots, although liquid fertilizers can be mixed with insecticides in some cases. Another way to apply fertilizers is to inject it into the trunk. Many workers have found that short-term beneficial effects result, but holes drilled in the tree to apply liquid "foods" provide entrances for a number of microorganisms, such as certain bacteria and fungi, that may cause trouble many years later.

Many species of trees, especially the broad-leaved deciduous trees of our climate, generally benefit ground limestone that contains both magnesium and calcium. This can be sprinkled on the surface or applied through bore holes in the soil.

Amounts and Kinds

How much fertilizer should be applied? A good rule of thumb for the NPK dry fertilizer is to use about 3 pounds of a 10-10-10 to each inch of diameter of large trees. Thus, a tree 10 inches in diameter would take about 30 pounds of fertilizer. If the tree is less than 6 inches in diameter, about 1 pound per inch of diameter is suggested.

The same fertilizer should not be used for all species. Conifers generally do best with large quantities of rotted organic matter such as cottonseed meal and dried maple leaves. NPK fertilizers should be used sparingly on most evergreens. Most broad-leaved evergreens do wel with a slightly acidic leafmold applied as a mulch with some 5-10-5 NPK fertilizer. Lime or wood ashes should not be applied to broad-leaved evergreens as a general rule. If magnesium deficiency appears to be present, indicated by leaves yellowing between the veins, ground magnesium sulfate can be applied.

Additions of ground limestone are also beneficial to many species broad-leaved deciduous trees. Some shrubs, like lilac, respond especia well to it. But other species can be damaged since an increase in soil alkalinity is injurious. Most broad-leaved evergreens thrive best wit leaf or bark mulches, rather than with limestone. Conifers may benefi from applications of limestone at a rate of about one part limestone to three parts of the garden-type NPK fertilizers.

Timing

Trees and shrubs are best fertilized in early spring when the frost is out of the soil, or in autumn when the leaves are beginning to turn or fall. Applications made then are less likely to cause injury to foliage as a result of overfertilization, especially with small trees and shrubs. Since nitrate nitrogen leaches from the soil fairly rapidly, annual applications are recommended.

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PROTECTION AGAINST INSECTS AND DISEASES

William E. Wallner

Northeastern Forest Experiment Station
Hamden, Conn. 06514

Trees in an urban setting are subjected to an array of problems that indirectly affect their survival and predispose them to the attack of insects and diseases. Through soil compaction and excavation, air and soil pollution, and construction, man creates changes that affect tree vigor. An insect or disease agent may detect decreased vigor of the trees, an attacks are initiated. There is a dynamic relationship between host and pest even though healthy trees may be attacked.

Insects, diseases, and other organisms can injure or kill trees, but their incidence is difficult to predict. Attack by these pests varies from year to year, being affected by such factors as tree and pest species, geographic location, and weather conditions.

Many pests found on urban trees have parasites, predators, or diseases that exert some level of biological control, but even so chemical controls are widely used at present because they offer the quickest remedial treatment. The impact of natural controls is not completely known; yet their role as regulators should be encouraged whenever possible -- in part because they are selective. Most chemical pesticides are not selective and can interfere with, or negate, efforts to control other pests on the same trees. For example, a pesticide may kill beneficial organisms that normally regulate the population of a pest, and thereby the pesticide may cause an increase in the pest numbers. Proper selection of a treatment or combination of treatments that is compatible with natural or silvicultural control is called integrated control. Applying such control over an extensive area (township, city, or park), monitoring the important factors (populations of insect pest, mites, disease, parasites, and predators), and establishing the economic or damage thresholds above which control procedures are invoked make up integrated pest management. While such management is used in the production of food crops, it has received little attention in the protection of urban trees.

Proper selection of tree species is extremely important in pest management -- whether a large number of the same species (possibly approaching monoculture) or a diversity of species (mixed culture) is used. There are advantages to monoculture: uniformity of shape, size, and texture, and comparable requirements for spraying, shaping, fertilizing, or other maintenance. However, past experience with monoculture, such as the American elm, is a sufficient reminder that it can result in massive problems. When a disease, insect, or other malady strikes, the number and proximity of susceptible trees favor an outbreak. Because trees can be relatively long-lived and are costly to remove and replace, mixed culture is often more desirable than monoculture. The lower likelihood of major losses tends to make diverse plantings more stable.

Proper diagnosis of pest problems is essential to efficacious action. Most pests have a critical period during which control is maximized, but the period may vary from year to year -- depending on the weather, pest, and host. Therefore, before attempting control, current recommendations should be ascertained. In all states information on pest control can be obtained from such agencies as the Cooperative Extension Service (County Agent or State University Extension Specialist), State Forester, State Entomologist or Pathologist, and the State Agricultural Experiment Station. Professional advice can also be obtained from consulting arborists.

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WOUNDS AND WOUND TREATMENTS OF URBAN TREES

Alex L. Shigo

Northeastern Forest Experiment Station
Durham, New Hampshire 03824

Wounds and Decay

Wounds are a major cause of injury to urban trees. Wounds start the processes that can lead to decayed wood, which can lead to hazardous, unattractive, and low-quality trees. Root, trunk, and branch wounds inflicted during building and road construction rank as a major type of injury. The injury is often not obvious until 5 or even 12 years later.

A would is a break in the bark that exposes the xylem. Once the xylem is injured it is never repaired, replaced, or restored to its previous healthy state. In this sense, tree wounds do not heal. Instead, trees wall off or compartmentalize wounded xylem. Compartmentalization is an alternative to healing that has great survival value for trees.

Decayed wood associated with wounds has been, still is, and no doubt will continue to be a major problem of all trees throughout the world, regardless of where they are growing. The classic concept of tree decay emphasized the characteristics of decayed wood, taxonomy of decay-causing fungi, and predicitons of the proportion of cull trees for great numbers of trees in forests. The expanded concept of tree decay includes compartmentalization -- the response of trees to wounding and infection, and succession -- the interaction of many types of microorganisms in the decay processes that can lead to discolored and decayed wood. Compartmentalization and succession are orderly processes which can be understood and regulated. The more that we understand of the decay processes, the better are our chances of regulating them. A model system -- CODIT, Compartmentalization Of Decay In Trees -- describes how discolored and decayed wood develops in living trees.

Treatments of Wounds

Commercially prepared wound dressings -- particularly the asphalt-based types -- do not stop decay; if the are applied in a thick coat they can increase it. The dressings are primarly cosmetic, and of phychological benefit to the tree owner. When wounds are treated, three factors must be considered: 1) closure, which is related to current growth rate; 2) dieback of cambium around the wound, which is related to the time of wounding and the position and severity of the wound; and 3) internal walling-off or compartmentalization of decay.

Results of recent research suggest that biological control agents such as the fungus Trichoderma harzianum delay the invasion of decay-causing fungi for at least 2 years in red maple. Research with other materials by the author shows that wound dieback can be decreased, and that other treatments delay the development of decay.

Compartmentalization of injured and infected wood appears to be under genetic control. Some trees of the same species can compartmentalize decayed wood to a smaller volume than other trees. This means that we may be able to select trees that can withstand the stress of many wounds over many years, and still have only small columns of decayed wood. This brings us closer to having decay-resistant trees.

Pruning and Injections

Pruning can help a tree, but if improperly done, it can hurt a tree. A pruning program should be established early in the life of a tree and continued throughout its life. The best time to prune a tree is late in its dormant period. The worst time is when the leaves are expanding, or soon after the leaves begin to fall. In the spring, the bark is loose and dieback may develop. In the fall, wood-inhabiting microorganisms produce an abundance of spores that can infect wounds. When pruning dead or dying branches, do not cut the living callus collar around the stub. This is an instance where flush cuts are not recommended.

Holes are frequently drilled deep into trees to inject chemicals. Great care must be taken when this is done. A hole is a wound. Repeated drilling over several years can cause severe internal injury. When internal columns of injured wood coalesce, large pockets of dead wood will result. Dieback around deep injection holes can also lead to cankers. When injections are necessary because of infection, the holes should be as few, as shallow, and as clean-edged as possible. Until better injection methods are developed, go about it carefully!

Seams from Wounds

Large, deep invaginated cracks, commonly called frost cracks, are usually not initiated by frost. Wounds start the process, and the cold or frost acts as a trigger. Most large frost cracks start from old wounds on the inside and spread outward. Weakened areas on the trunk also act as starting points for other types of seams, especially when temperatures drop rapidly. These seams are usually very shallow.

Detection of Decay and Treatment of Decayed Trees

Decay can make trees hazardous. An electric pulsed-current meter -- the Shigometer® -- gives information that can be used to detect decayed wood rapidly and accurately in living trees. When cavity fillings are planned, this new device can also be used to determine the best installation of rods and other hardware. The use of the Shigometer® requires skill and practice.

When cavities are filled, great care should be taken not to clean out the decayed wood so thoroughly that healthy wood inside the tree is injured. The decayed wood is compartmentalized in the tree by a tough rim of protective tissues. If this is broken from the inside, decay will spread rapidly from the cavity to the surrounding healthy tissues. Cavities can be filled for esthetic reasons or to form a base for the developing callus.

The length of time that a tree can remain safe and attractive can be extended by cabling and bracing. When hardware is put into healthy tissues, the injured wood will be compartmentalized. But when holes are made in decayed wood, the decay will spread rapidly into the surrounding healthy tissue. When hardware is used in a trunk that has decay, the rod must go completely through the stem, and washers must be place on the outside. The washers will hold the rods in place even though decay may develop around the rod. Do not dead-end rods that penetrate decayed wood.

Holes drilled into decayed wood to drain water can cause severe injury to a tree, because decay will spread rapidly. Bu holes can be drilled into wetwood without spreading decay. Wetwood is a wood condition caused by bacteria; the wetwood is not decayed.

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REDUCING CONSTRUCTION DAMAGE TO SHADE AND WOODLAND TREES 1/

Silas Little

Northeastern Forest Experiment Station
Pennington, N. J. 08534

Damage to shade and woodland trees can be prevented or greatly reduced if certain measures are taken. The following guidelines are suggested.

Installing Underground Utility Lines

- Use tunneling as soon as roots 1 inch in diameter are encountered, except when in the vicinity of trees less than 6 inches dbh (diameter at breast height). In these cases, either tunnel under the crowns or locate the trench so it is outside of the crown cover.

- Near old and large trees, take great care not to disturb soil-moisture relations.

- If a root system is reduced, reduce the crown by a similar proportion.

- Fertilize and water affected trees to aid their recovery--if watering if feasible.

Making Road and Grade Cuts

- Remove trees back from the cut for a distance of 1 foot for each foot of depth of cut, e.g., 10 feet back for a 10-foot cut.

1/ Material extracted from an unpublished paper: Yingling, E.L., O.A. Keeley, S. Little, and J. Burtis, Jr. Reducing damage to shade and woodland trees from construction activities.

. On minor grade cuts, as the grade of a short slope between house yards and a greenbelt, an alternative is to mulch the cut and the area under affected trees (use wood chips), and to fertilize and water these trees.

Making Fills for Roadways

. Use enough culverts so spaced that drainage in the adjoining soils is modified as little as possible--neither impounding water in wet periods nor increasing the drainage rate so water tables are lowered.

. Dredging channels is inadvisable in many wooded swamps because in porous soils the water levels may be lowered throughout the swamp.

. Maintain culverts in good working condition.

Constructing Home Developments

. The least damage is done to existing trees when:

(a) Roads are planned, laid out, and constructed well in advance of house construction--especially when roads are built with as few cuts and fills as possible.

(b) Soil levels around remaining trees are not altered by grade cuts or fills, or by stockpiles of soil excavated from cellars.

(c) Construction equipment is prevented from injuring roots or boles of remaining trees. Heavy equipment compacts the soil and changes the root habitat, and roots may die. Partial injury of boles may cause only long-term damage, as from heartwood rot, which becomes critical over an extended period.

Proper treatment may save affected trees. If dieback starts, remove a portion of the crown by topping; if stem sprouts develop, thin and manage the sprouts to form attractive crowns.

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MANAGEMENT OF NATURAL AREAS

Silas Little

Northeastern Forest Experiment Station
Pennington, N. J. 08534

History and Definition of Natural Areas

The Forest Service, stimulated by Aldo Leopold and others, has been a leader in designating and setting aside natural areas. Its first natural area was designated in 1927, and by 1940 the Forest Servic had designated 31 such areas. In 1947 the Society of Americal Foresters (SAF) established a committee to promote establishment of natural areas on public and private lands. Since then many states, through their forestry or park departments, such organization as Nature Conservancy and the Society for the Protection of New Hampshire Forests, and other Federal agencies such as the Fish and Wildlife Service of the Department of Interior, have desigtated areas in their ownership as natural areas.

The Forest Service, and especially the SAF, originally defined a natural area as "An area set aside to preserve permanently in unmodified condition a representative unit of the virgin growth of a major forest type primarily for the purposes of science, research, and education. Timber cutting and grazing are prohibited and general public use discouraged" (from SAF Forestry Terminology, 1944).

More recently the U. S. Forest Service and others have modified these standards. The Forest Service has established natural areas for research that represent examples of major forest types whether or not these types are due to past disturbances. The U. S. International Biological Program of 1967 called for "preserving examples of typical environments, both those relatively little disturbed by man, and those which he has materially modified." However, such areas are still preserved primarily for long-term scientific use as natural laboratories to study ecosystems in all their complexity, but also serve as check areas and reservoirs of genetic materials.

In contrast, natural areas set aside by some states and other organizations are used for research, education, and recreation. For example, the Natural Areas System Act of New Jersey calls for (1) areas of limited access dedicated and restricted to ecological research, (2) areas for public interpretation of natural processes where the development of nature trails and educational facilities is permitted, and (3) areas with minimal interference by man where certain recreational activities, such as swimming, boating, hiking, hunting, fishing, and overnight camping are permitted. For some organizations, nature education is the prime use of their natural areas.

Management of Natural Areas

If natural areas are to be of the most value for scientific studies, restrictions on general use by the public seem necessary. If they are to serve for nature education and still provide examples of vegetation not greatly affected by human use, trails should be laid out and surfaced with materials such as wood chips or crushed stone, public use should be confined to such trails, and collecting plants for any purpose should be prohibited.

Recreational use, if permitted, should be low enough so that its impact is minimal. If use is high, then restrictions on access might be instigated. Another alternative might be to construct surfaced paths for hiking and pads for camping, along with restricting most activities on those prepared sites. If such measures are not taken the areas soon might not qualify for even the most liberal definition of natural areas.

Some natural areas have been designated as samples of subclimax forest stands; of bogs where rare ferns, orchids, or other plants grow under open conditions; or of grasslands or shrublands in sections where forests prevail in the absence of disturbances. Some of these areas may also form suitable habitats for threatened or endangered plants or animals. However, in all such areas, past disturbances, such as fire, are responsible for the present conditions; in the absence of further disturbances, the existing vegetation will--sooner or later--be replaced by more climax species. Scientists in charge of such areas should know what changes to expect and be prepared to provide (1) suitable habitats for new stands or (2) treatments, as prescribed burns, to maintain existing vegetation. In some cases, studies may be needed to determine habitat requirements, especially for endangered plants or animals.

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Local silviculturists may advise on specific treatments for native species. For other plants, local ecologists and silviculturists may be able to provide references to studies of habitat requirements, and to suggest treatments that create suitable habitats. Local wildlife managers or other biologists may be able to provide similar help on animal habitats.

MUNICIPAL WATERSHED MANAGEMENT

Edward S. Corbett

Northeastern Forest Experiment Station
University Park, Pa. 16802

Municipal watersheds have long provided quality water for domestic use, and have generated income from timber production. They are also a source of recreation and esthetic pleasure. Recreational benefits and esthetic considerations are increasingly being incorporated in metropolitan planning studies, and our managers of urban resources must consider these aspects of municipal watershed use.

The Municipal Watershed

The primary function of a municipal watershed is to provide domestic water supplies (often including those for local industries), and may be privately or publicly owned. The municipal watershed includes drainage-basin lands, protection land around reservoirs, or well fields and their recharge areas. Many municipal watersheds constitute the principal forested areas within an urban environment.

Timber products from sawlogs to Christmas trees can be harvested while maintaining water quality, and water yields can be increased by proper management of the vegetation. Recreational benefits, esthetic value, and education can also be supplied, but recreation must be carefully managed to avoid a deterioration in water quality.

Multiple use of municipal watersheds is illustrated by the current policy of the City of Newark, New Jersey, in managing its Pequannock Watershed. Major objectives include maintaining the quality of water, while providing direct benefits to city residents. These benefits are obtained by providing new revenues from a land-use development of a small portion of the watershed and by shifting the tax burden on some watershed properties through leases or conservation easements. The new policy opens some land to recreation and education, but such use is regulated by a sensitivity classification of the lands.

Another example of multiple use of watersheds is found in Baltimore, Maryland. Their management is also based on a coordinated program for the production and protection of water, the improvement and utilization of timber, and for recreational use. At Baltimore and elsewhere, municipal watersheds provide sites for outdoor education. Teachers use nature trails, woods roads, and streams for class trips; at times they are aided by watershed managers or foresters who explain the production, protection, and treatment of water, and the reasons why various forest practices are used.

Water Yield and Quality

Water yield can be increased by periodically harvesting timber on portions of municipal watersheds. In the East, the increase in water yield the first year after heavy cutting will be from 5 to 12 inches. The maximu increase measured on research watersheds is 16 inches. Of special value is the increase in low summer flows. Regrowth for 5 years can reduce the water-yield increase by two-thirds; partial cuttings under all-age manageme have much less and a shorter-lived effect on water yield than do heavy cuttings.

Cuttings provide income from timber sales and, under proper managemen improve the growing stock. On large municipal watersheds many types of timber products are harvested because of the diversity of timber available While timber-harvesting opportunities on small municipal watersheds are not as great, managers have a ready market for cordwood -- which brings up to $80 a cord in some areas.

Erosion can be minimized and high-quality water maintained in logged areas by the proper location, construction, use, and maintenance of loggin roads and skid trails. Increases in stream temperatures may result from harvesting, but can be minimized by retaining streamside trees for shade.

Before programs of vegetation management are begun, their effects on esthetic value and recreational use should be conisdered. Many municipal watersheds are the major open spaces in urban-industrial landscapes. Proper cutting can create vistas within the watershed property and enhance wildlife and plants. In one municipal watershed area with a deadened overstory, hikers were attracted to a woods road through it because of better visibility and the opportunity to observe plants and songbirds not found in mature forests.

Water quality can be, and often has been, improved by reforesting abandoned, eroding fields, but water yields are reduced. On the Baltimore municipal watersheds, a cooperative study showed that conversion of open land to young pines caused a decrease of 238,000 gallons of water per acre per year. This is equivalent to about 9 inches of water per acre. Hence, such conversion programs should be carefully evaluated. Mixed hardwoods would not reduce yield as much as pines; open fields, if feasible to retain, benefit water yield and create a diverse habitat for wildlife.

Where only a small portion of a watershed is municipally owned, special management problems arise. If adjoining properties are wooded and the cooperation of their owners can be obtained, a coordinated management program can be initiated. Protection of water quality and maintenance of reservoir-storage capacity are a primary importance, but in developing urban areas this may require special sediment-control measures. Effective management can prevent or reduce the man-caused eutrophication of both urban lakes and reservoirs.

Timber and other management of municipal watersheds varies with available manpower. Some watersheds are managed by foresters who have their own crews. In some watersheds, timber sales are handled by State or consulting foresters. Some municipalities have work programs for high-school students or unemployed persons to help on forestry or erosion-control projects.

Watershed Recreation

Recreation of some type is allowed on 59 percent of the municipal watersheds of the Northeast, and on 89 percent of those of the Southeast. Fishing, hunting, and hiking are most frequently permitted. Little boating, swimming, or water skiing is allowed, especially in the Northeast and Far West. Several municipalities use a permit system to limit the number of people on the watershed at one time.

The American Water Works Association asserts that water-supply reservoirs should not be used for recreation if other surface waters are available. Distribution reservoirs that supply water directly to the public require the strictest controls, and under no condition should they be used for recreation. Managers of each water utility are responsible for their product's quality, and should therefore determine the type and extent of recreational use. If water-contact recreation is permitted, complete water treatment is a prerequisite. To safeguard public health and the quality of the watershed, proper supervision of recreationists and provision for sanitary conveniences and garbage disposal are essential. Watershed managers will have to determine the number of people that can be handled without creating sanitation problems and without adversely affecting recreational values.

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Review.

MANAGING FORESTS FOR ESTHETIC BENEFITS

Robert O. Brush

Northeastern Forest Experiment Station
Amherst, Mass. 01003

Many private owners of forest land and many visitors to publicly-owned forests in and around cities of the Northeast derive much of their satisfaction from the esthetic quality of woodlands. This discussion will review some of the available information for managing woodlands in urban areas for scenic enjoyment.

Many of the features that make some forest settings more scenic than others are difficult to change or to manage -- features such as hills and mountains, waterfalls and ponds. Among features of forest settings that can be changed easily are the structure of stands and the species composition. By thinning and pruning forest stands, it is possible to vary the degree of canopy closure, the height of the canopy, stand diversity, tree spacing, the amount of understory, and the size of clearings. To a person passing through a woodland, the characteristics of different stand structures can stimulate a range of responses.

The species composition of naturally regenerated stands can also be varied through management and will depend upon the available seed sources, the site conditions, and the structure of the stand. Through management, mixed species that contrast in foliage color and texture, flowering, and bark can be encouraged to add visual interest.

A large tract of woodland of the same stand structure could generate more esthetic enjoyment if it were subdivided into many stands, each with a different structure. The stand structure can range from dense stands of small stems to open stands of a few large stems, to open clearings and parklike groves. A variety of stand structure is possible with even-age or uneven-age silvicultural systems.

The standards for scenic quality of forest stands can vary considerably among individuals and among groups, depending upon their attitudes toward conservation or their preferred recreational activities. Before developing plans for esthetic forest management, the standards of the users should be considered, whether the client is a private landowner, a conservation commission, or a city park commission.

Although certain stand structures may be more esthetically appealing to some than to others, much of the appeal of attractive stands lies in their uniqueness and their contrast with more common stands. The key to esthetic forest management is the diversity of stand structures. A mix of stands that ranges from young to old, dense to open, small stems to large, would assure that as a stand matures and evolves into a different stand structure, it will be replaced by a similar stand elsewhere in the forest.

Diverse tree-stand conditions should help to provide a diversity of nonarborescent plants. Many herbaceous plants require open spaces, while others need light shade and little or no competition from shrubs. Forbs with showy flowers, or interesting plants such as the insectivorous sundews and pitcher plants, or rare ferns may be favored by prescribed burns or other disturbances. Local ecologists may be able to prescribe conditions that should be created to favor different plants.

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MANAGEMENT OF WOODED AREAS FOR SONGBIRDS AND OTHER WILDLIFE

Richard M. DeGraaf

Northeastern Forest Experiment Station
Amherst, Mass. 01003

Birds and other wildlife are enjoyed by millions of urban and suburban residents. About one family out of four feeds birds, and over $500 million is spent annually in the United States to see, identify, feed, and photograph birds. Urban and suburban forests provide very important habitats for a variety of birds and other wildlife. What considerations should be given to songbird habitat needs when managing urban forests?

Size of the Urban Forest

Each habitat type or successional stage has a characteristic wildlife community--this is just as true for an urban forest as it is for a National Forest. Generally, the larger the urban forest, the more habitat types it will contain, and thus the greater its potential to support a more diverse wildlife community. For the most part, urban forest managers will be dealing with birds that are characteristic of edge habitats. From a regional standpoint, many of the forest interior species have been eliminated through fragmentation of the forest cover. Urban forests, usually 10 to 25 acres in size, apparently contribute little to the habitats used by most warblers, cuckoos, and other birds that are associated with larger areas of woodland.

Breeding Habitat

To produce the greatest diversity of birds, the full range of successional stages normal to the forest type should be present. Killdeer nest on the bare ground of cultivated fields. Meadowlarks, bobolinks, and grasshopper sparrows use grassy fields. As brush appears, the habitat becomes suitable for the nests of chipping and field sparrows and quail. Tall shrubs and sapling stands are used by rose-breasted grosbeaks and rufous-sided towhees. Scarlet tanagers, cuckoos, and red-eyed vireos frequently nest in pole stands. Mature and old-growth stands are important breeding habitats for wood and other thrushes, but especially for cavity-nesting species. The primary cavity nesters--woodpeckers--excavate nests in dead limbs or trunks. Secondary cavity nesters--nuthatches, wrens, screech owls, crested flycatchers--nest in cavities created by woodpeckers. Virtually all cavity-nesting birds are insectivores, and so are valuable components of urban bird communities.

In urban forests, snags should be retained if at all possible. Not only do they provide sites for cavity nesters, they provide food for nestlings, and perching sites for aerial feeders such as phoebes and kingbirds. Downed logs provide habitat for many salamanders, snakes, and other little-seen wildlife that nevertheless are important to the urban ecosystem.

Mixed and coniferous stands will privide breeding habitat for those species that prefer to nest in conifers. The first nests of robins, for example, are usually built in conifers before hardwood trees produce leaves. Mourning doves, pine warblers, blue jays, and crows are some of the other species that commonly nest in conifers.

Winter Habitat

Urban forests are extremely important as winter cover for birds. Birds need to get out of the wind and weather; shrub thickets, stands of conifers, and cavities in snags and dead limbs enable them to survive winter storms and cold nights. Coniferous stands on the north and west sides of urban forest tracts should greatly reduce the wind and provide more secure wintering habitat for birds.

Water

Water or wet areas are important to many birds--snipe, water thrushes, goldfinches, redwings, and palm warblers. Brushy borders of wet places also provide nesting and escape cover for song sparrows, catbirds, and cardinals. Of course, the pond or marsh is vital to the frogs, toads, salamanders, muskrats, and other wildlife often found in urban forest areas.

Habitat Security

Security from people and pets is a major problem for urban and suburban birds, especially during the nesting season. Ground-nesting species are generally not found in built-up areas, but can be found on estates and farms. In order to produce a self-sustaining population, bird species need a secure habitat. From such a habitat they will disperse into surrounding neighborhoods where residents can see and enjoy them. Generally, the lower a species nests, the more vulnerable it is to disturbance by people and pets. Shrub thickets allowed to form behind ponds or marshes, especially thorny thickets, will provide more secure habitats away from trails or paths. Snags allowed to stand in wet areas or steep places away from trails will help provide secure nest sites for cavity nesters.

Fruit-bearing shrubs, especially those that retain fruit in winter, will provide a more secure habitat for many wintering birds. Shrubs such as multiflora rose, highbush cranberry, viburnums, dogwoods, winterberry, and other hollies are excellent providers of winter food for such birds as robins and mockingbirds, as well as grouse and pheasants. Plants that produce fleshy fruits, such as elderberries, blackberries, and juneberries, are readily consumed by late summer, and while of great value then, generally are stripped of their fruit long before winter. Other valuable plants for songbird management in urban woodlands are flowering dogwood, autumn olive, honeysuckles, blueberries, mountainash, red mulberry, and vines such as grapes, virginia creeper, and poison ivy.

Urban forests can be made more enjoyable for human residents by attracting wildlife. Meeting the food, water, and cover needs for a variety of birds and other wildlife will render urban forests attractive to a diversity of species.

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A general review, filled with practical information.

WOODED AREAS MANAGED FOR INTENSIVE RECREATION

Herbert E. Echelberger and Silas Little

Northeastern Forest Experiment Station
Durham, N.H. 03824 and Pennington, N.J. 08534

One of the most important objectives of intensive recreation management is to provide the desired recreation areas without damaging the vegetation. If use becomes too heavy, understory vegetation and sometimes the forest floor disappear and the soil becomes compacted, which may lead to sheet and gully erosion, especially on slopes. As a result of such changes, overstory trees may develop crown dieback, which may necessitate the annual removal of dead or dying trees to eliminate hazards to recreationists.

In areas used for educational purposes, nature trails do not cover so large an area that severe damage to the trees develops. Nevertheless, measures must be taken to prevent eroding trails and damage to understory plants. Rare plants may disappear--sometimes because of avid collectors who have herbariums and terrariums!

From the forester's viewpoint, recreation resources depend on proper planning, construction, and management, which are intimately related; and recreational objectives control the decision-making on each.

Planning and Construction

The production of foliage and other nonwood materials and the growth of associated nontree vegetation, such as shrubs, grasses, and forbs, should be considered early in the planning stage of a recreation area. Rapid growth of vegetation, soil stability, and the persistence of vegetation with minimal care should also be considered. Planners and landscape architects now have a greater choice of plant species that will serve these purposes, but they may wish to emphasize the maintenance of native vegetation.

The plan should include estimated construction costs and the sequence of development, as well as management options after the recreation area is in operation. For example, planners should determine if and when the rotation of recreation areas is feasible. If it is, rotation plans should be included in the development sequence. In such cases, when an area shows signs of overuse, the manager will direct users to a new area and allow the old one to "rest" for one or more years--until vegetation and soil recover, possibly aided by specific treatments. It is important to remember that planners recognize rotation as an option, and that they develop areas so that this can be easily accomplished. However, many popular sites are associated with water recreation or some activity that makes rotation difficult or unfeasible.

Another option that should be considered is whether to limit the number of visitors in an area or to channel users to prepared paths, camping pads, or pads for picnic tables. These "hardened sites" are covered with wood chips, blacktop, crushed stone, or other materials that reduce erosion and minimize soil compaction. Terraces and steps can be constructed on the steep slopes of paths. Trails can be routed to angle down the slopes, and water bars can be installed to divert water from paths during wet periods. Fencing or thorny shrubs and vines can be used as barriers to channel visitors to the prepared paths.

While many of these measures are applicable to heavily used sites for picnicking, camping, and hiking, they may not be appropriate for the areas devoted to such activities as swimming (although they may be needed on approaches to the swimming site). For areas near swimming sites, understory shrubs may be more of a hindrance than help; a turf cover may be more suitable.

Management

Even with sound planning and construction, unforeseen factors can result in recreational use that exceeds the capacity of the area. In such cases, management must be flexible so that remedial measures can be taken. These measures may be simple. The desirable vegetation should be maintained, and it may be sufficient to remove dying trees and to plant new ones. In many areas arboriculture techniques could be employed--the use of large stock, fertilizing, and perhaps fencing and watering.

Additional measures may be needed to reestablish understory plants or a ground cover. If many trees have died, it may be desirable to establish a turf cover. For this, it may be necessary to haul in topsoil (especially on eroded sites); then till, fertilize, seed, and perhaps water the area. Afterward, the usual procedures for turf management should be followed annually.

If most of the overstory trees are still alive, other measures can be taken. Mulch, such as wood chips, can be applied to check erosion and help the soil to gradually recover from compaction. In areas where further use has been prohibited, but where light and moisture conditions are favorable, volunteer plants may soon provide a good understory cover. Understory growth can be hastened by planting--provided that there is no vandalism, continued use, or cutting and mowing. In this case, certain species of woody or herbaceous nursery plants or wildlings can be planted successfully. However, heavy shade, washing deposits of soil, leaves, wood chips, and droughty soils can make such planting unsuccessful, depending upon the species. Results from a Maryland study showed that 90 to 100 percent of such shrubs as winterberry, inkberry, spicebush, and azalea survived and many thrived, though the 3-year survival of mountain laurel and lowbush blueberry was about 60 percent, and their vigor was very low.

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DISPOSAL OF WASTEWATER AND SLUDGE IN WOODED AREAS

Edward S. Corbett

Northeastern Forest Experiment Station
University Park, Pa. 16802

The Problem

Rapid population growth, industrial expansion, and urbanization have increased both the demand for water and the problem of meeting the requirements for waste disposal established by Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972). Wastewater discharged from efficient sewage treatment plants usually meets public health requirements, but it is still enriched with nutrients and often contains considerable amounts of synthetic residues. In recent years, land application has been proposed as an alternative for renovating wastewater and using sludge.

The discharge of effluent into natural bodies of water can result in eutrophication and alteration of the normal balances in streams and lakes. Fish and other aquatic life may be significantly harmed. Increased nutrients may result in a prolific growth of aquatic plants that detract from the esthetic and recreational values of the streams or lakes, and degrade the quality of domestic water supplies.

In land application, the entire biosystem -- soil, vegetation, and microorganisms -- is involved in the renovation of effluent for groundwater recharge and the utilization of sludge. At controlled rates of application to maintain aerobic conditions in the soil, organic and inorganic constituents are removed and degraded by microorganisms in the surface soil by chemical precipitation, ion exchange, biological transformation, and biological absorption through the root systems of plants.

Land application of wastewater helps conserve urban water resources through groundwater recharge, and improves the quality of recycled waters. However, proper application rates and system design are necessary to ensure the adequate maintenance of forest ecosystems and the quality of recharge water.

The Land Disposal System

The quantity of wastewater applied to the disposal site must not degrade the soil moisture and plant relationship. A balance must be established between the amount of nutrients applied and the ability of the soil-plant system to retain them. There should be no direct runoff of the wastewater to streams, and no percolation of polluted water to the groundwater. The application of wastewater must be limited by the amount of nutrients or pollutants than can be used by the plants or immobilized in the root zone. A recommended procedure is to apply the permissible amount of wastewater and then divert the water to another area while plants and microorganisms act on the nutrients applied to the first area.

Land disposal can be used where:

. Infiltration, drainage, and storage capacity of the soil can accommodate wastewater applications on a year-round basis.

. The soil has the ability to fix and hold the effluent nutrients for subsequent use by plants and microbes, and has the capacity to prevent the migration of contaminants to groundwater, especially in winter months when plants and microbes are less active.

. Topsoil and subsoil are sufficiently permeable to provide good drainage and thick enough to renovate the effluent before it reaches the groundwater reservoir.

For land disposal operations on a year-round basis, the system must rely more on the absorptive capacity of the soil during cold months, and less on microbes and plants. Forested areas are more suitable for winter disposal than cropland because they provide better conditions for winter infiltration. But soils in agricultural areas, where crops are harvested annually, remove more nitrogen and phosphorus than in forested sites. Lagoons or other storage facilities may be needed when the flow of wastewater varies considerably, is too little to justify continuous pumping, or during periods of heavy rainfall or extremely cold weather when disposals are not made.

Wastewater from many sources has been used in land application. These include waste lagoons, secondary treatment plants for sewage, industries (including cooling water), food processing plants, and livestock-feeding operations. To determine whether land disposal of a particular liquid will be satisfactory, the criteria include:

- Water must not contain dangerous disease-producing substances.
- Substances in the effluent must not be detrimental to the soil, plants, and other organisms, and must not adversely affect percolation.
- The volume must not exceed the renovation and disposal capability of the available land.

Wastewater from most sources must be pretreated before it is applied. Treatment of domestic sewage should include the removal of heavy solids, the equivalent of secondary biological treatment, and the disinfection of treated effluent.

The ratio of land area to effluent disposal is determined by dividing the amount of wastewater and/or sludge by the load permissible for the site (with rate of application accounted for). Loading rates vary with the sites and depend on the type, depth, and water-holding characteristics of soil, the subsurface geology, plant cover, and climate. Each site must be evaluated independently. In populated areas, additional land may be required to provide a buffer strip around the disposal site to avoid complaints about drifting spray and possible health hazards.

A proper system of monitoring is needed on all sites to assure the protection of groundwater. Local zoning regulations, land-use policies, health codes, nuisance laws, and state and local permit requirements must be satisfied before a disposal system can be installed.

Effects on Forest Ecosystems

Applications of wastewater or sludge may be beneficial or detrimental to forest ecosystems. In studies at The Pennsylvania State University, municipal wastewater applied at 1 inch per week resulted in a slight increase in the diameter growth of oaks, a substantial increase in maples, and an increase in both the diameter and height growth of red pine. At 2 inches per week, there were large increases in the diameter growth of oaks, aspen, and white spruce, but significant reductions in both height and diameter growth of red pine. Irrigated trees grown for pulp had an improved wood-fiber structure.

The long-term effects of effluent on plant composition and density, chemical composition of soil, microorganisms, and wildlife are uncertain, but they probably vary with treatment and site. In mixed hardwood stands at The Pennsylvania State University, effluent irrigation tended to reduce the amount of tree reproduction. Heavy metals and other toxic substances may accumulate. The length of time that forests can efficiently remove nutrients is questionable -- more so than for harvested agricultural crops. At the university, forested areas handled 1 inch of effluent per week during the growing season without the mean annual concentration of nitrate nitrogen exceeding water quality standards; but where 2 inches per week were applied year-round, that concentration at the 48-inch soil depth exceeded the Public Health Service (PHS) limit for drinking water. In contrast, in an area of reed canarygrass that received the same 2-inch treatment, the nitrate-nitrogen concentration remained well below the PHS limit.

Applications of liquid-digested sludge have aided in revegetating drastically disturbed sites, such as strip-mined areas.

Effluent applied by spray irrigation may cause ice damage, windthrow, or bark damage in forested areas. Ice damage can be somewhat minimized by a properly designed system that uses low-trejectory rotating sprinklers. Windthrow can be minimized by an untreated buffer strip 50 to 100 feet wide on the windward side of the irrigated area. Bark damage as a result of spraying can be avoided by using nozzle pressures of less than 55 psi.

Possible Roles

Agricultural areas adjacent to forest provide the greatest flexibility in land disposal; but this combination is more adaptable to small cities and suburbs than to large metropolitan areas because of available open land close to treatment plants. Special land uses, such as Christmas-tree growing; nurseries for forest trees or ornamentals; cultivation of hybrid poplars, sycamore, or cottonwood for pulp silage; sod production; and energy plantations offer the advantages of both high-value crops and more frequent harvesting (with uptake of nutrients) than the usual forest crops.

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HOUSE-LOT LANDSCAPING FOR WILDLIFE

Richard M. DeGraaf

Northeastern Forest Experiment Station
Amherst, Mass. 01003

Planting residential grounds to attract wildlife is not new, but there has been a resurgence of interest in this in recent years. Published accounts of techniques to attract birds began to appear in the 1930's, although surely people had employed them earlier. The basic idea is simple--provide food, water, and cover in a suitable arrangement, and birds will take advantage of the habitat.

How is the rich backyard habitat created to attract a variety of species? Here are some basic principles and suggestions for plant species that will enhance urban and suburban properties for birds and other wildlife.

Planting Plan

The first step is to make a scale plan of the property, or the portion to be planted, showing the house and other permanent features. This plan is needed to ensure that all efforts to attract birds with plantings complement one another, and to avoid mistakes. It is common to see houses, built 20 or 30 years ago, virtually obliterated by towering blue spruces or other conifers planted by the front steps. These trees looked attractive as a foundation plantings when they were small, but now darken the windows and make house maintenance difficult.

Make a plan of the yard as if it didn't have any trees or shrubs. When planning the arrangement of the trees, shrubs, and flower beds, it is wise to keep a few principles in mind. Keep large evergreen such as hemlocks, spruces, and pines to the sides and rear of the property, preferably on the north side. This will prevent shading the yard and will reduce winter winds. Arrange smaller trees in front of this green backdrop. One can hardly choose a better small tree than flowering dogwood for beauty throughout the year and for attracting birds. Several planted in a small grove are especially attractive. The flower clusters in the spring set off a yard, and the red berries that ripen in late summer and early fall are readily eaten by almost a hundred kinds of birds. Robins especially prefer them. Plant other trees, shrubs, and vines that will provide food through the critical period--winter through early spring--and which will look attractive.

Birds use trees, shrubs, vines, and herbaceous plants for food, for shelter from wind, cold, and storms, to escape predators (in your yard this is likely to be a cat), and as nesting places. Choose plants that provide these requirements and that have attractive foliage, fruits, and branching patterns.

Concentrate massed plantings to the sides and back of the yard. This will prevent the view from a window or terrace from being obstructed, and will eventually form an effective green wall which will show off flowering and fruiting trees and shrubs.

Trees

Evergreen trees such as hemlock and white pine are used by robins, wood thrushes, blue jays, and grackles, among others, for nesting, and the seeds are eaten by pine siskins, pine grosbeaks, and crossbills. Blue and white spruces, and white fir are used by nesting mourning doves, chipping sparrows, and mockingbirds. Among deciduous trees, sugar maples are used by robins, orioles, goldfinches, and red-eyed vireos for nesting. If you have large deciduous trees, resist the urge to cut off dead branches and stubs. These dead parts abound with insects for woodpeckers, chickadees, and nuthatches, and also provide softer wood where these cavity nesters can excavate nests.

Some other deciduous trees that bear fruit are the mountain ash, serviceberry, Russian mulberry, and pin cherry. These are all small trees, and produce a profusion of fruits that are magnets for many bird species. Two other small trees to consider are the box elder and Washington hawthorn. Some people consider the box elder a less than ideal ornamental tree, but the winged seeds are a favorite food of wintering evening grosbeaks. The Washington hawthorn has thorny branches and dense foliage and is a preferred nesting tree for many kinds of birds, especially catbirds, brown thrashers, mockingbirds, and robins. The red fruits persist through the winter and so provide a good supply of emergency food. This tree is a fine upright ornamental which is especially beautiful after leaf-fall, when the red fruits stand out against the gray branches. Another advantage of Washington hawthorn is that it is probably the hawthorn most resistant to infection by cedar-hawthorn rust.

Shrubs

Many bird species live very close to the ground, and are dependent upon shrubs for food, nest sites, and cover. Song sparrows, for example, feed on seeds on the ground, nest on or within a yard of the ground, and if they are frightened, fly close to the ground to the nearest thicket.

In wet areas or in odd corners, consider planting a few clumps of elderberry. The elderberry provides a showy flower display in summer after most other shrubs have bloomed, and the heavy panicle of dark purple berries attracts many species of birds such as chipping and song sparrows, indigo buntings, cardinals, catbirds, and bluebirds.

Some other deciduous shrubs that provide fleshy fruits are Siebold's viburnum, gray dogwood, arrowwood, the amur and tatarian honeysuckles, highbush blueberry, and European cranberrybush.

In addition to arrowwood and gray dogwood, consider red-osier dogwood, alternate-leaved dogwood, common winterberry, and bittersweet. Several exotics are proven bird attractors--Russian olive, autumn olive, and multiflora rose. These all grow in almost any soil, and produce fruit in abundance. The multiflora rose retains its fruit all winter, and is one of the best plants for providing escape cover and nest sites for many birds, especially song sparrows, mockingbirds, catbirds, and brown thrashers. Be sure that there is room to let multiflora rose "go"--it grows to a thick, often climbing mass. Of course, the wilder it grows, the more cover and fruit it produces, but take care where it is planted. Incidentally, this rose was heavily planted in the 1950's along highway median strips, and many ornithologists believe it was an important factor in enabling mockingbirds to spread north to New England. Mockers certainly use it for nesting, and in winter the birds here are usually associated with this fruit-bearing rose.

Some evergreen shrubs should complement plantings. Junipers provide not only berries, but also protection from predators and the weather, and are good nesting sites for chipping sparrows. When yews have grown to a fair si.e, they are used by nesting mockingbirds and robins, and they also produce fleshy red berries which are eaten by several species.

Herbaceous Plants and Vines

In an odd corner of the yard, behind the garage, or near the compost pile, one can do a lot for bird visitors by doing essentially nothing. Instead of creating or maintaining more lawn, consider reducing your mowing time by letting a part of the yard go. This can be attractively done by increasing the grass heights in strips from the lawn to the tall grasses and weeds, much as a golf green blends into the fairway and finally the rough.

It is hard for domestic plants and flowers to compete with "weeds" in seed production. Some weeds (which are merely flowering plants that tend to grow where they are not wanted) are heavy seed producers. Some examples are pokeweed, lamb's quarters, timothy, orchard grass, knotweed, and ragweed. Over time, plant succession--true natural landscaping--proceeds from grasses and weeds such as goldenrod, daisy, and black-eyed susan through blackberry, silky dogwood, gray birch, black cherry, and eventually maples. Behind this natural area consider letting poison ivy grow--its waxy berries are a choice food of catbirds, flickers, brown thrashers, myrtle warblers, and are also taken by bluebirds and chickadees.

Another vine to plant is trumpet-creeper. The orange flowers attract hummingbirds, and it should be planted near a porch post or a trellis where the vine can climb and where one can see the hummers up close.

Water and Feeders

Besides arranging useful plants in the yard to provide cover, nest sites, and fruits year-round, what else can be done to attract birds? First of all, provide water. This requirement is so often lacking in yards. The vessel need not be elaborate--a pan of water on the ground or a standard birdbath will serve. A small pool is a fine garden feature, and can be simpl made by digging a small pit about 3 or 4 feet wide and 1 foot deep, and lining it with a sheet of plastic. Line the bottom with small stones to give it a quite natural appearance, and place an inverted flower pot in the bottom to support a twig on which birds can perch and drink. Feeding birds varies from throwing crumbs on the snow to establishing a vast catering setup that costs hundreds of dollars each year. It needn't cost a fortune, but there are techniques for making winter feeding a real success. Through all of your feeding efforts, keep in mind that you are doing it so that you can continue to see birds up close, in large numbers, throughout the winter. Birds have existed for a long time without feeders, and would merely disperse and feed on natural seeds, fruits, and insects without them. But, since the construction of housing developments and highways is destroying bird habitat, the role of feeders may become more important.

Bird feeding should be used as a device to see birds up close. It is much more important to plant residential grounds to meet the year-round needs of birds than to merely put out a feeder.

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COMMUNICATIONS

Richard F. Watt

Northeastern Area, State and Private Forestry
U.S. Forest Service, Broomall, Pa. 19008

Urban forestry is a relatively new field, and good communications are essential to further its objectives. For example:

- As better methods of controlling pests are discovered, the urban forester concerned with pest control should know about them.
- Urban landscape planners and architects should know about improved tree varieties so that they may consider them for planting.
- Urban foresters should know about proposed legislation that would affect the funding for urban tree work, or zoning that would protect greenbelts.
- Arborists should know about the development of improved equipment for the care of trees or the removal of dead trees.
- Taxpayers should know about the work of publicly employed tree-care professionals in order to provide the needed support to prevent the curtailment of government funds.

Good communications, then, expedite the flow of information from scientist to practitioner, from practitioner to practitioner, and from professionals to the layman--in short, to all those interested in the problems and benefits of the urban forest.

Communication in urban forestry can be considered in two phases: communications among professional workers, and communication between the professionals and the general public.

Communications between professionals in urban forestry are somewhat difficult to establish because of diverse training, interests, and backgrounds. Professionals who are concerned with urban forestry and its many facets include arborists, foresters, landscape architects, horticulturists, planners, soil scientists, hydrologists, entomologists, pathologists, and nurserymen. These people are found in private employment, from one-man businesses up to large corporations, and in all areas of public employment. Yet each makes an important contribution to the overall knowledge and experience that must be shared. Those in one profession must have an appreciation of the work of those in others, and an understanding of how the entire field of knowledge can be integrated.

Professional societies are an important means of communication. The International Society of Arboriculture is a well-established organization that publishes the "Journal of Arboriculture." The Society's national annual meeting and annual regional meetings provide a forum for formal and informal discussion. The Society of American Foresters has fostered a renewed interest in urban forestry, as witnessed at a recent SAF national convention that devoted a considerable portion of its program to urban forestry -- the Urban Forestry Working Group of the SAF has conducted lengthy programs at the convention for the past two years.

The "American Nurseryman" is a well-established journal that is concerned with the problems of producing the planting stock used in urban forestry programs.

Other important publications are "Weed, Trees, and Turf," "Grounds Maintenance," and "HortScience." Journals are also published by the larger arboreta, such as the Arnold Arboretum, the Brooklyn Botanic Gardens, and the Morton Arboretum. The American Association of Botanical Gardens and Arboreta publishes the "Arboretum and Botanical Garden Bulletin."

Local associations are an excellent means of exchanging information; their meetings often focus on regional problems and possible solutions. The scientist can gain from the practitioner and legislative officials can learn of changes in ordinances that will be helpful in raising the level of municipal arboriculture.

The New Jersey Federation of Shade Tree Commissioners sponsors a well-attended annual meeting where commissioners can exchange information about tree care. The Federation also publishes "The Shade Tree," which is of value to arborists and others in New Jersey and adjacent states. The Massachusetts Tree Wardens' and Foresters' Association and the Michigan Forest and Parks Association are other examples of organizations that promote the care of urban trees. Besides its annual meeting, each year the Michigan Association conducts several workshops to discuss selected topics, and where urban forestry practices can be seen under actual conditions.

The Extension Service offices at the state land-grant colleges also actively disseminate information on shade tree care through publications and meetings. For more comprehensive coverage, particularly of the scientific literature, "Horticultural Abstracts," "Forestry Abstracts," and the "Bibliography of Agriculture" can be found in the larger libraries. National Urban Forestry Research provides a semiannual review of research projects underway and the workers involved.

The lay public and the public officials who generate the interest and support for many urban forestry activities may include some well-informed and motivated individuals who are concerned with the role of vegetation in their communities, but who may have minimal contact with the thinking of the professional working in urban and community forestry. The layman is seldom a member of a professional society and may not be able to attend local professional meetings. Nevertheless such individuals are important in providing support for urban forestry programs.

More popular causes--such as education, law enforcement, fire protection, roads, and parks--have constituencies that rally to their support. But adverse changes in a city's shade-tree population develop so slowly, barring a sudden outbreak of disease or insects, that they often go unnoticed until it is too late to correct them, so the struggle for funding becomes a distinct handicap.

The Arbor Day Foundation, with its promotion of Arbor Day and the Tree City USA awards, and the Extension Services at the land-grant colleges have long been in the forefront in establishing communications with the lay public. But local communities usually are severely limited in funding for basic tree care so they seldom can indulge in the luxury of an expensive campaign to reach the general public. Yet, there is a great reservoir of interest in trees by the general public that remains untapped by the professional urban forester, who can turn the good will into strong public support.

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EVALUATION OF TREE LOSSES

Brian R. Payne

Northeastern Forest Experiment Station
Amherst, Mass. 01003

There are several different ways to assign a monetary value to tree losses. These have been described in some useful publications that are listed in the references. The problem is to decide which valuation metho to use in a particular situation.

As a general principle, no one method of valuation is appropriate in every case. There is no use trying to determine the intrinsic value of a tree; values of anything are relative and comparative, not fixed and absolute. Therefore, common sense is needed to select a valuation method appropriate for the situation, comparison, or choice at hand. The key question in choosing the method is: Why evaluate?

Three common reasons for ascertaining the monetary loss from a dead tree are to seek damages from the person or agent responsible for the lo to claim a casualty loss deduction from income taxes, or to file an insurance claim for the loss. Less common reasons might be to seek abatement of property taxes where trees have died, or to determine a reduction in selling price of real estate. Another reason might be to estimate the value of potential losses in order to decide how much to spend for protection of trees from insects, disease, or other hazards.

Information is needed about the tree or trees that have died or been killed. A simple, specimen tree in a yard or park is valuable primarily for beauty and shade. A fruit tree may be valuable primarily for its annual production. A tree being grown for sale at Christmas has a value limited to its market price on or before December 24. A tree in a woodlot has a value based primarily on its conversion into boards, pulp, or fuel.

When the motive for valuation and the use of the tree have been determined, choose a method of valuation that makes sense, Even then, recognize that not everyone will agree with the method chosen.

Some methods of valuation are based on (1) replacement cost, (2) contribution to property value, (3) formula or point systems, (4) annual crop production, (5) conversion to wood products, and (6) cost basis.

Replacement Cost

This is probably the most objective method and the easiest to use, but only for relatively small trees. It is based on the market value of nursery stock plus planting cost. It is likely to be acceptable in damage claims, but it may produce values higher than those that an insurance company or the Internal Revenue Service (IRS) is willing to accept.

Contribution to Property Values

This method of valuation is useful primarily for trees on private, residential property. It is calculated as the value of the entire property with a tree or trees minus the value of the property without the trees. Actual or appraised property values are determined on a before-and-after basis. This is the method of valuation accepted by the IRS for determining allowable deductions for casualty losses. With this method, the value of all trees on a property cannot exceed some percentage of the value of the property (perhaps 12 percent for properties with houses, 25 percent for unimproved residential property). Thus, this method cannot account for historical, specimen, sentimental, or other special values sometimes attributed to large trees.

Formula or Point Systems

These methods are inherently arbitrary, but they are based on experience and may yield realistic and consistent values. The best-known formula, published by the International Society of Arboriculture, begins with an arbitrary value (currently $13) per square inch of cross section trunk area (basal area) measured 4-1/2 feet above ground level. Basic values are then reduced by factors for species, condition, and location. This system is complicated, requires judgment in its application, and is intended for use by professional tree and plant specialists.

A related system, used by the British Arboricultural Association, assigns point values to trees based on size, life expentancy, position in the landscape, presence of other trees, relation to the setting, form, and special factors. The product of the point values is expressed in pounds sterling.

Formula values are best suited to single ornamental or shade trees and they are useful for trees on public as well as private property. The IRS does not accept this method. Insurance companies may accept formula values in theory, but in practice most homeowner policies limit liability to a fixed amount ($250 to $500) per tree. Formula values have been accepted in some court decisions.

Annual Crop Production

This method is useful for estimating the value of loss of fruit, nut, or other trees that produce an annual crop. The market value of the annual crop over the average remaining life expectancy can be discounted at interest to obtain a present net value for a tree that has been killed. This method is appropriate only for a commercial enterprise where the only value of the tree is assumed to be its crop yield.

Conversion to Wood Products

The loss in value for trees being grown primarily for conversion into wood products (cordwood, pulpwood, plywood, or lumber) can be readily obtained from local market prices, either for these products or for stumpage (the wood-product value of trees on the stump). This method is not appropriate for ornamental or shade trees, or for single trees except when they have extraordinarily high values for conversion into veneer or specialty products (e.g., black walnut).

Cost Basis

This method assumes that a tree is worth what it costs to get it in place and keep it there -- planting cost and maintenance cost capitalized over the life of the tree. Cost-basis values are useful in very limited circumstances: they may be used to estimate casualty-loss deductions from Federal income taxes for commercially grown trees, an uncommon situation in urban forestry.

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REGISTRATION AND REGULATION OF PESTICIDES

C. L. Hatch

Northeastern Area, State and Private Forestry
U.S. Forest Service, Broomall, Pa. 19008

Definition of Pesticides

By legal definition, a pesticide is any substance for which a manufacturer or distributor claims pesticidal value. Most pesticides are chemicals; however, some are living biological agents such as bacteria, fungi, or viruses. Pesticides are used to control all kinds of pests and are grouped according to the types they control -- insecticides to control insects, fungicides to control fungi, herbicides to control weeds, and avicides to control birds.

Pesticides by their very nature are poisons and, if used improperly, can endanger man and animals. Today there are more than 32,000 pesticide products registered to destroy, prevent, attract, or in some manner, control pests. The risks or hazards of chemical pesticides have increased in recent years with the sharp rise in their use. This, of course, has resulted in increased Federal and State legislation to regulate their use.

Pesticide Regulations

The first Federal effort to control pesticides was the Insecticide Act of 1910. Since then, two other major acts have been passed to regulate their use more closely. The are The Federal Insecticide, Fungicide, and Rodenticide Act of 1947 (FIFRA) and The Federal Environmental Pesticide Control Act of 1972 (FEPCA). This latest Act is often referred to as FIFRA amended.

Some of the major provisions of FIFRA as amended are:

- All pesticides must be registered with the U.S. Environmental Protection Agency (EPA). Qualified states may also register pesticides under special conditions.
- All pesticides will be classified for either general or restricted use.
- Only certified applicators, or those under their supervision, may apply restricted-use pesticides. States have the authority to certify applicators.
- Use of a pesticide inconsistent with labeling instructions is prohibited.

These provisions, and others, are enforceable through civil and criminal courts where VIOLATORS MAY BE FINED OR IMPRISONED OR BOTH.

The process for registering a pesticide is very complex and expensive. Years of research may be needed to collect data that will support an application for registration. Probably the most costly research deals with potential cancer-producing components, birth defects, and other types of disorders that may result from the chemicals; for this research, test animals must be exposed to small quantities of the chemical over long periods.

Because of the expense, pesticide producers are often unable or unwilling to register pesticides for minor pests or minor uses. As a result, the pesticide user--especially the urban forester--frequently must control a pest for which there is no legally registered pesticide.

Before 1972, pesticide users could apply any product against any pest. However, with the misuse provisions of the new FEPCA law, this practice is now illegal.

To help solve this problem, the EPA allows states to register pesticides for special local needs. A state can register a pesticide for use at additional sites, against additional pests, or at different rates than those listed on the Federally registered label. The major requirement for state registrations is evidence that shows the proposed change is effective against the target pest.

A key part of registration and the EPA safety review is Rebuttable Presumption Against Registration (RPAR). All pesticides registered before 1972 (approximately 32,000 products) have to be reexamined to assure they meet the new safety requirements. If a pesticide shows potentially dangerous characteristics, it is subjected to intensive scientific review and public comments before a decision is made on whether to allow continued use or to begin cancellation procedures.

Pesticides are classified for general or restricted use. In addition to EPA restrictions, states have drawn up restricted pesticide lists--in some cases more strict than EPA's. When EPA announces the restricted use of certain pesticides, an applicator must be certified by the state in which the pesticide is used. General-use pesticides may be used by anyone.

Certification of Applicators

Certification is obtained by passing examinations administered by a State Pesticide Regulatory Agency. These agencies are usually located within each State Department of Agriculture. They can provide information on the times and places that tests are given, and answer questions about State laws and regulations.

Training in preparation for State tests is provided by the State Cooperative Extension Service. Information about training is available from any County Agent or Extension University in your state.

Additional information on Federal laws and regulations is available from EPA Regional Offices or from EPA Headquarters, 401 M Street SE, Washington, D.C.

The most important point for the urban forester to recognize is the implications of the MISUSE provision of the new Federal and State laws. This provision is enforced by both the EPA and State regulatory agencies. READ THE LABEL and follow directions precisely.

Questions can also be addressed to Environmental Quality Evaluation, S&PF, NA, 370 Reed Road, Broomall, Pa. 19008, Tel: 215-596-1672.

URBAN FOREST PLANNING

Gary Moll

Maryland Forest Service
Mechanicsville, Md. 20659

The design and structure of urban communities in this country have largely ignored the existing land features during the land-development process. Forests, woodlands, and trees are necessary to a community, and when we fail to incorporate these natural features in urban planning, we lower the quality of life in these areas.

Historically, professional people with knowledge and experience in managing natural systems have been absent or at least tardy in the urban-planning process. This unfortunate situation is slowly being remedied by urban foresters.

The economics and logistics of forest management are severely taxed by urban development. Woodlots suffer first from neglect, then fragmentation, and finally extinction. Earth-moving equipment plows under established vegetation, rearranges land contours, mixes soil strata, and crushes air spaces out of soil aggregates. The urban gridwork is engineered, constructed, then occupied, and the life-support values of forest vegetation are eliminated from the urban community. It is not until this juncture that the importance of forest vegetation is realized.

The establishment and maintenance of trees in the urban environment is difficult and sometimes impossible. Usually, considerations of existing topography, natural drainage patterns, friable soil structure, and healthy forest vegetation are all foolishly omitted from the urban community plan, but they can be retained through proper planning.

The pitfall in any type of planning is the failure to relate planning issues and activities to practical and productive solutions. Some planning endeavors have lost credibility by generating massive volumes of technical data that are difficult to interpret and, at times, impossible to apply. Many existing principles of forest management can be applied to the developing urban community in a practical form so that the forest or trees will be protected.

It is through urban forestry that trees become a viable part of the urban community. Trees can be protected and maintained during the development process. Roadways and utilities can be planned to allow for tree growth. Superior cultivars rather than weed trees can be planted. Natural contours and natural soil strata can remain intact within the urban zone.

The value of trees in reducing climatic extremes, controlling runoff, filtering out polluting particles from the air and water, reducing noise, providing esthetic enjoyment, creating wildlife habitat, recharging aquifers or watershed storage basins, supplying wood fiber, and functionir as a carbon sink provide persuasive argrments to convince civic groups, land planners and developers, local and state officials, and the general public, of the importance of maintaining a relationship between forest and urban lands. The contribution of urban foresters can give trees in an urban area a fighting chance on many levels--from delineating adequate-size street lawn for shade trees to identifying, outlining and preparing management plans for full-scale city forests that can eventuall produce a sustained yield of products.

The urban forester must maintain an extensive library of resource material and pull together information from various disciplines that is scattered throughout the literature of other academic and professional fields. Ideas and technical methods must be drawn from sources outside the forester's or arborist's traditional sphere. The Urban Land Institu the American Society of Landscape Architects, the American Planning Association (formerly the American Society of Planning Officials and the American Institute of Planners), and the National Association of Home Builders are some of the organizations that the urban forester shoulc seek out for information.

The degree to which forest management or shade-tree culture is practiced in the day-to-day activities of the urban forester depends on the location of his project area. Nevertheless, the range of his information on the role of trees and forests in the urban community and his knowledge of management techniques will form the basis and the extent of his participation in the planning process.

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Keywords: Urban, city, community forestry, street trees

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