TRENDS AND ISSUES IN CITY FORESTS[1]

by J. James Kielbaso

Abstract. A survey of 2,787 city tree managers in 1986 resulted in a 38% return. Only 38% know with certainty how many trees are on their streets. There are an estimated 61,654,000 street trees in the 7,043 U.S. cities represented. If spaced 30 feet apart they would occupy 1,937 square miles. It is estimated that there are 10 private trees for each street tree. The average value per street tree in 47 cities able to estimate, is $525. Annual expenditures to maintain these trees average $10.62. At 6% interest this expenditure would reach $500 in 23 years. Tree care remains only .49% of city budgets, and although increasing to $2.60 per capita from $1.63 in 1974, has increased less than other city services. The ten most often occurring and planted trees are enumerated. Street trees are spaced about 105 feet apart, which is about 43% of potential stocking. A goal of the American Forestry Association, in cooperation with ISA, is to plant 100 million trees in cities by 1992 in the Global ReLeaf project to help ameliorate the CO_2 buildup in the global atmosphere. This is an action program requiring input from everyone possible in order to attain success.

Résumé. Un sondage effectué auprès de 2787 responsables municipaux des arbres a eu un retour de 38%. Seulement 38% savent avec certitude combien d'arbres sont dans leurs rues. 61 654 000 arbres de rues sont estimés dans les 7043 villes américaines représentées. S'ils étaient espacés de 30 pieds, ils occuperaient 1937 mille carré. On estime qu'il y a 10 arbres privés pour chaque arbre de rue. La valeur moyenne d'un arbre de rue, dans 47 villes capables de l'estimer, est de $525. Les dépenses annuelles pour entretenir ces arbres sont en moyenne de $10,62. A un taux d'intérêt de 6%, cette dépense atteindrait $500 dans 23 ans. Les soins arboricoles représentent seulement 0,49% des budgets municipaux. L'augmentation à $2,60 per capita, comparée à $1,63 en 1974, est moindre que d'autres services municipaux. Les dix arbres les plus rencontrés et plantes sont énumérés. Les arbres de rues sont espacés d'environ 105 pieds, ce qui est environ 43% de la possibilité de plantations. Un but de l'Association forestière américaine, en coopération avec ISA, est de planter 100 million d'arbres dans les villes d'ici 1992, dans le cadre du projet 'Global ReLeaf' pour améliorer le taux de CO_2 dans l'atmosphère. C'est un programme d'action qui requiert l'aide de tous et chacun pour réussir.

Beginning in 1974, there have now been three nationwide surveys completed to assess the conditions of the city forests in the United States (6, 13). The most recent was conducted in 1986 and first reported in 1988 (9). In 1986, 2,787 cities were surveyed, including all over 10,000 population, and a sampling between 2,500 and 9,999, with a 38% return. Readers interested in details on the survey technique, questionnaire and its analysis are referred to the above reports. This is a report on several aspects of the survey.

The Urban Forest

Our urban trees have long been known by those in the fields of arboriculture and urban forestry to be of great value. Their virtues have been extolled widely as they signficantly enhance urban esthetics, economics and ecology (3, 15, 16). Evidence of the advantages of urban trees to health and public safety are reviewed by Moll and Gangloff (12). Recent articles dealing with comfort values of trees and householder evaluations of individual species further attest to the values of trees (2, 17). Few doubt that tree lined streets are more pleasing than treeless urban areas and that living is more pleasant in neighborhoods with many trees. Reports of trees adding value to property and of raising taxes collected through increased assessments are common. There are estimates that Milwaukee has received financial benefits between fifty and one hundred times the purchase cost of flood plain and watershed lands because of increased property values nearby (4). There are even old reports of as much as 100-300% increases in a year around Central Park (14).

What is this place we call the urban forest? Street trees are one of the basic resources for which a manager is responsible. Of the respondents to the survey, only 38% knew with a degree of accuracy how many street trees were in their city. Although the number of street trees varies with the sample, Table 1 shows the number of street trees by city size. It is my conclusion that the most realistic estimate of the total number of street trees in our urban forest is 61,653,904, rounded to 60 million. If these trees were evenly spaced 30 feet apart, they would occupy an area

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of 1.24 million acres, about the size of the Everglades or Grand Canyon National Parks, 5 times the size of Rocky Mountain National Park, or about ½ of Yellowstone. The same area would be about 1,937 square miles, or about equal to the 1932 square miles of Delaware.

Grey and Deneke (7) have estimated the total extent of the urban forest, or more correctly urban area, to be about 69 million acres, and this is expanding rapidly in several sections of the country. Considered from this perspective, the urban forest is about the size of Colorado or 2 Michigans.

The 60 million street trees account for only the street ROW's not taking into account any of the park or yard trees. I've recently obtained data to report on later that suggests that there are an additional 12 trees for each street tree in the small to medium sized cities that make up such a great percentage of our cities. If a more conservative 10 is used, then there are about 600 million urban trees that would, at 30 x 30 spacing, similary occupy an additional 19,369 square miles, which is a little smaller than West Virginia.

Values and Costs

Having addressed the size or extent of the city forest, a consideration of its economic value should be of interest. The average value of street trees has increased as expected from $343 in 1974 to $525 today. A median value of the 47 cities that provided sufficient data to permit calculating the value of individual trees suggests $500. This would support a claim of value of the 60 million street trees, at $300, or $500 each, of $18, and $30 billion, respectively.

Another way of appraising the value of this urban forest is to consider the annual costs devoted to maintaining this resource. Tables 2 & 3 present the mean and median costs per tree by city population and region. The mean expenditure of $10.62 per tree is about the same as 1980, but the median of $8.04 is an increase of nearly $2.00 from 1980. This would seem to suggest an overall increase, although probably also a slight reduction in those cities that were higher.

Projecting the $10.62 mean and $8.04 median annual expenditures for different numbers of years at a conservative 6%, produces a $500 tree in 23 years, and 27 years, respectively. Even though reports of much shorter life spans for urban trees are reported, evidence of standing trees in many cities suggests that it is quite feasible to have trees 25 to 30 years old, or even older. There will have been a $500 investment in these trees under a management program.

Another comparison is with other selected city services, specifically police and fire protection,

Table 1. Numbers of street trees in the U.S., mean and median, by city population, 1986.

Population (thousands)	*Reporting*	*Cities in category*	*Median*	*Mean*
over 1,000	1	6	---	680,000
500 - 999	5	17	140,000	161,334
250 - 499	13	34	59,610	118,154
100 - 249	40	113	39,120	64,894
50 - 99	71	280	20,000	34,595
25 - 49	115	616	11,800	16,490
10 - 24	138	1545	5,600	13,614
5 - 9.9	6	1744	360	1,492
2.5 - 4.9	11	2284	250	1,059
			30,075,910[1]	61,653,904[2]
All cities	400	7043	11,000	29,677

[1]Sum of median number of street trees in size categories multiplied by the number of cities in category.
[2]Sum of mean number of street trees in size category multiplied by the number of cities in category.

and refuse collection. Table 4 presents expenditure for these services, along with tree care on a per capita basis. Police at $103.22, fire at $68.28 and refuse at $32.41 far exceed the $2.60 per capita for tree care. Each has increased considerably since 1974, but the increase ratio shows that the differences are increasing as shown by the fact that trees increased by 1.60 since 1974 while police increased by 2.66 over the same period. Further evidence that urban tree care has not been blessed by frugal city budgets in recent years is the fact that the average tree care budget as a percent of city budget is only 0.49%, remaining below 1% for each of the surveys. With increased environmental concern and awareness, this perceived problem could well become our challenge and opportunity. In fact, when we asked Detroit residents how they would personally change expenditures, the responses were very positively to plant and care for trees (5). Only education ranked higher on the redistribution of tax dollars, and the most favored locations were residential tree lined streets.

Figures 1 and 2 show how the $10.62 budgets are distributed. Street trees receive 61% and park trees 26%. These are little changed over the three surveys with park trees increasing slightly at the expense of the other minor categories. Likewise we cannot discern any difference of more than two percent among the work activity categories. The 'big three' continue with trimming at 30%; removal, including stumps, at 28%; and planting at 14%. Just as there are differences in actual dollars spent per tree and per capita between regions and city populations, so too, are there regional and population differences between the various categories of expenditures. Cities in the West spend considerably more for trimming and watering than other cities, but much less for removal and planting, while many cities in the North Central spend more for removal and less for trimming, as a result of Dutch elm disease.

Cultural Issues

The difference between removal and planting percent expenditures, 28% and 14%, at first would suggest a net loss of trees in cities. However, two other facts counter this conclusion. First, the average cost to remove is about twice the cost to plant; $134-$63 in-house and $219-133 contracted. Thus, we may conclude roughly equal numbers since removal percentage of budgets is twice planting. Second, when a plant/remove ratio was calculated from the 401 cities able to provide number of plantings and removals, the means for the ratios were between 1.74 and 2.63 trees planted for each tree removed.

Table 2. Average annual expenditure per tree by region, 1986.

Region	*Mean*	*Median*
Overall	$10.62	$8.04
Northeast	6.92	4.84
North Central	10.26	9.36
South[1]	10.31	6.00
West	13.11	12.87

[1]Each category represented by at least 32 responding cities except South region.

Table 3. Average annual expenditures per tree by city size.

City size	*Mean*	*Median*
Overall	*$10.62*	*$8.04*
(thousands)		
over 1,000[a]	*13.24*	*13.24*
500 - 999[a]	*9.11*	*7.14*
250 - 499[a]	*12.24*	*12.60*
100 - 249	*11.95*	*11.00*
50 - 99	*11.83*	*10.37*
25 - 49	*10.61*	*9.56*
10 - 24	*9.86*	*7.69*
5 - 9.9[a]	*11.98*	*6.00*
2.5 - 4.9[a]	*3.89*	*3.33*

[a]*Fewer than 16 respondents for population group suggests caution when drawing conclusions from data.*

Table 4. Annual per capita expenditures for selected services by city size, 1987.

Population (thousands)	*Police**	*Fire**	*Refuse**	*Trees*
Overall	*103.22*	*68.28*	*32.41*	*2.60*
Over 1,000	*240.88*	*78.24*	*34.04*	*2.14*
500 - 999	*135.01*	*78.22*	*32.36*	*1.31*
250 - 499	*104.27*	*69.54*	*34.73*	*2.41*
100 - 249	*95.85*	*69.11*	*30.79*	*2.88*
50 - 99	*95.66*	*69.45*	*30.55*	*2.96*
25 - 49	*86.69*	*65.53*	*33.05*	*3.14*
10 - 24	*88.25*	*55.32*	*33.80*	*2.17*
5 - 9.9				*3.29*
2.5 - 4.9				*1.36*
Increase ratio 74/86	*2.66*	*2.42*	*2.29*	*1.60*

**Source: Municipal Yearbook - 1988.*

However, the plant/remove ratio median is about 1.2 trees planted for each removed. This is a positive figure if the numbers represented all removals and plantings, rather than omitting the removals of the small, newly planted trees that fail to survive planting. This would reduce the planting ratio below 1 and suggest a net loss. The situation may be worse in larger cities, where a survey of 20 cities has shown that about four trees die or are removed for each tree planted (11).

Table 5 presents ratings of the ten most commonly occurring species on city streets and those most commonly being planted. Of the commonly occurring list, sycamore has been replaced on the list by green ash. Of species most commonly planted crape myrtle has replaced crab apple. Silver maple and flowering pear have increased significantly on the occurring and planting lists, respectively. Six genera represent the top 10 species in both rankings. Two genera contain 6 of the 10 top planted trees. This certainly misses the proposed goal of not more than 10% of a genus, nor 5% of a species in a city's population. It was reported, based on the 1980 data, that 75% of trees being planted on streets were represented by 7 species nationally, as few as 4 in the north central region and by as many as 10 in the West (8). Even in the West, this suggests an average of 7.5% for each species, in the region with the richest planting mix. Based on these numbers, it seems apparent that there is a continuing need to use more species to produce greater diversity in our urban forest population.

The estimated number of street trees planted nationally has decreased somewhat from 1980 to 1985, from 1.5 million to 1.1 million annually. This should in no way suggest that this satisfies the need for trees in our streets. In fact, the survey data suggest that nationally there are 102 trees per mile of street, with a median of 100. The median 100 trees per mile means that the trees average 105 feet apart. Many professionals believe we should space trees at about 40-50 feet spacing. This means that we should be able to plant, at 50 feet spacing, a few more than the 60 million existing trees; in fact 66.7 million more trees to obtain full stocking at 50 feet apart. At the planting/removal ratio of 1.2, it would take 267 years to reach full stocking! This number has entered into consideration for a program I'll speak about in a few moments, Global ReLeaf. In a different analysis of 22 cities, McPherson and Rowntree (10) concluded that city streets are about 38% fully stocked at 45 feet spacing. The figures above, recalculated at 45 feet would produce an estimate of 43% stocking. In cooperation with the American Forestry Association, U.S. Forest Service, and State Foresters, we are currently sampling in about 400 cities to verify some of this information as well as be able to estimate the condition of urban trees.

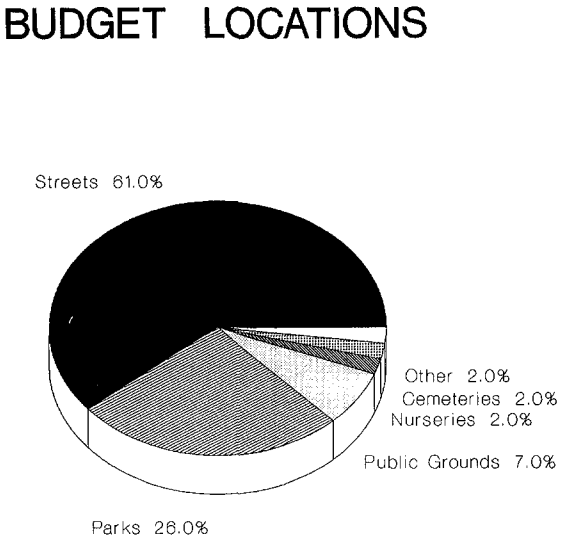

Figure 1. Budget allocations by location of street trees

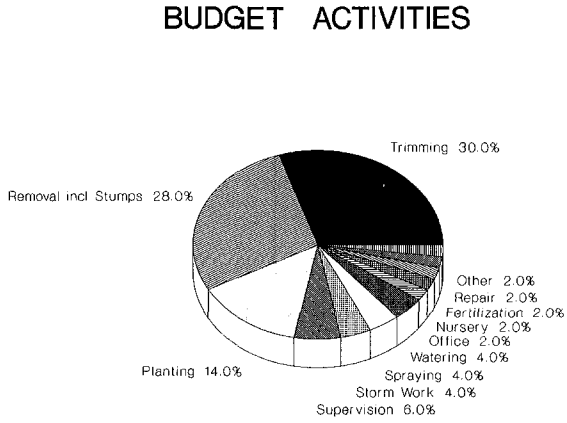

Figure 2. Street tree budget allocations by activity

Management Issues

An interesting condition has evolved since the first survey some 14 years ago. When responding to a question about whether or not they were managing their trees systematically, 56% of responding cities were affirmative in 1974, 50% in 1980, and only 39% in 1986. We are either receiving responses from different representatives, or cities are steadily losing ground to crisis management, which is what I believe to be the actual case. I'm suspicious, and hopeful, that the trend may not be so severe, but it nonetheless represents a decrease in proactive management.

A more serious cause for concern is that only 16% (15-17) of responding cities have an "urban forest management plan". Fully 80-85% of our U.S. cities have no plan in place for managing this invaluable resource. Only slightly better, 27% have some plan for dealing with tree related problems in the event of an emergency or disaster. Again, fully 70% do not have a plan for dealing with extreme conditions. Clearly, if we are to manage urban trees in the most effective and efficient manner, there is much room for improvement; 80-85% in planning, 70% in planning for emergencies, and 50-60% in systematic management.

A much higher percent (61%) of cities have at least a tree ordinance that defines responsibility for tree care in the city. Certainly, there are many variations, but nearly ⅔ address this issue. Not so for the so called "tree preservation" ordinances which place some restriction on the cutting of trees on private property. Although they have increased from 11% to 13%, the figures are not sufficient to say they differ at all because of rounding error, or that there is a trend. Preservation ordinances, also called woodlands ordinances, among others, seek to restrict unnecessary removal of trees and are especially applied in areas of rapid development. It is of note that the occurrence of such an ordinance has not increased, especially since it is at such low levels at this time. The number of trees leads to another interesting statistic. For those cities that know the number of street trees, the average number is 0.5 trees per person, as provided by the tree managers and combined with city population. The estimated number of trees nationally, when divided by the U.S. population yields a smaller trees/capita number of 0.27. Even though this is a rather large percentage difference (50%), it is sufficiently similar to add confidence in the estimate of the number of city street trees. An interesting verification of this is that the street trees/capita for 22 cities is reported as .37 by McPherson and Rowntree (10).

Just about half (49%) of cities conduct or participate in Arbor Day activities. An even greater 62% are aware of the tree city USA program, but only 26% of the cities participate as a tree city.

Many of the larger cities operate a nursery to supply all or part of their tree needs. Twenty four percent of the cities have a nursery. The average size is 7 acres, but since the largest is reported as 300 acres it skews the average. The median is only 2 acres. With half of the city nurseries occupying less than 2 acres, they are probably not producing all of their plant materials, but are more likely to be producing some special material or are holding material there for a short time. Responses indicate that about 87% of street trees are purchased for immediate planting, with another 11% held at least a year.

Planting survival is probably not as high as desirable. For those able to report, the following is

Table 5. Most frequently occurring and planted street trees nationally, 1986.

Rank Order	*Species*	*Rating*[a]
Occurring		
1	"Maple"	1183
2	Norway maple	932
3	Oaks	851
4	Silver maple	833
5	"Ash"	686
6	Elm	666
7	Honeylocust	583
8	Sugar maple	570
9	Linden	497
10	Green ash	450
Planting		
1	Norway Maple	972
2	Flowering pear	832
3	Linden	779
4	Green ash	647
5	Honeylocust	599
6	Red maple	468
7	"Maple"	460
8	Sugar maple	346
9	Crape myrtle	321
10	"Ash"	288

[a]Weighted according to rank of listing: first = 6, sixth = 1.

the mortality rate for the first two years by several methods of planting: bare root, 14.7% first year, 7.2% second year; B & B, 9.6% and 5.3%; tree spade, 9.8% and 7.2%; and container, 10.5% and 6.3%. These seem high at first, but when difficult urban conditions are recognized, it is perhaps good. These are likely some of the best survival situations, since most people are unable to provide such information.

Membership in professional organizations is a primary means for receiving current information of use in the field. This continues to be one of the greatest opportunities for improving the conditions of trees in our cities. Table 6 shows the membership patterns of respondents and shows that only 33% of the most likely group belong to the ISA, which also happens to be the highest.

With a total of 6,664 municipalities over 2,500 population and 3,015 counties over 2,500, or 4,463 cities and 2,840 counties over 5,000 population, there is a tremendous need for information to better care for trees and an opportunity for organizations like ISA and the NRPA to serve and at the same time gain members.

What are the opportunities for the commercial sector of our industry? From only the perspective of city street trees, the percentage of cities that contract rose from 39% to 49% of our sample and the size of contract increased 25% on average over six years earlier. The important fact is that 43% believe that they will contract more in the future, 44% will remain the same and 13% believe they will contract less. There should obviously be an increase in this type of work, for those who choose to compete for it.

The number of cities intentionally planting streets to single species (28%) and the number with the practice of planting smaller ornamental trees (54%) have remained constant from the previous survey. However, the listing of most frequently planted trees does not fully support the size conclusion, as only the flowering pear and crape myrtle would likely be considered small.

Future

In the future, there are two items of special note. There are solid, steady efforts to enact federal legislation that would benefit urban forestry. In the House, a specific urban forestry bill has been introduced by Representative Jim Jontz and bills in the House and Senate have urban forestry components in broader energy bills. It is certainly hoped that one or more bills will become law. Then, funding will be the continuing challenge. With the issues of energy conservation and the buildup of CO_2 and the concurrent global heating, Congress, and even some in the Administration, are anxious for some legislation. We need to let our legislators know of the importance of trees and request their support.

The American Forestry Association, last year began its Global ReLeaf campaign to reduce the rate of CO_2 buildup through the use of trees. The most obvious and attractive goal for us, I believe, is the goal to increase planting of trees in cities to offset the urban heat island effect. Research has demonstrated the possibility of reducing home air-conditioning costs by 10-50 percent. The same research by Akbari et al. (1) also clearly shows tree planting to be the most cost effective way to conserve energy resources.

Therefore, the Global ReLeaf program has as one of its goals the planting of 100 million trees in our cities, properly located, by the end of 1992. If you thought a million trees in Los Angeles for the Olympics was a big effort, imagine 100 times the effort. It should be easily attainable if we each do our part, one of the main assumptions of Global ReLeaf. Akbari identified places strategically around homes for planting the first 100 million trees. A most impressive statistic produced by Akbari is that it would require the planting of 1.5 billion trees in rural forests to equal the direct and indirect effects of planting 100 million in cities; a 15 to 1 ratio. An urban tree is up to 15 times more important in reducing carbon dioxide build-up than a rural tree! I am amazed by this figure. Allowing that perhaps Akbari is off by 50% because of

Table 6. Membership patterns of city tree managers, 1986.

	Number reporting	*% of 6,664 cities*	*% of 2,787 sampled cities*	*% of 1,062 returns*	*% of 660 responses*
ISA	214	3	8	20	33
SMA	49	1	2	5	8
NRPA	198	3	7	19	31
SAF	55	1	2	5	9
ICMA	58	1	2	5	9

some assumptions, it is still 7-8 times! Even if it is only 2 or 3 to 1, it still makes the planting of trees in cities a high and very valuable priority. The data presented here suggest that we could, additionally, be able to plant another 60 million trees along our streets to bring the streets to full stocking, but the 267 years that would currently be required is too long. All of these CO_2-using trees, that shade and cool us so that we require less energy to cool us should have a positive impact. Although it can't completely offset energy generation, tree planting is a good first step. The other Global ReLeaf goals are to increase productivity of our traditional rural forests and to bring an end to tropical deforestation. In the rural forests, increased plantings to reach full stocking of forest areas, genetically improved stock for maximum growth, application of all available management practices, and wise use will help by capturing at least a ½ billion tons of carbon dioxide each year.

In the tropics, forests are being cleared at an estimated rate of 27 million acres per year—about 500,000 trees per hour. Most are removed from further forest growth. Our government needs to 1) stop funding "development" projects that cause forest cutting and consequent changes in land use that do not include forests, 2) support research on sustainable tropical forest use and 3) help the tropical countries deal with their economic development challenges in ways that respect their rights and dignity while halting the net loss of tropical forests.

Summary

How to accomplish all of this is the challenge to all of us. Assuming that all of these are desirable goals, the largest single problem as I interpret the data is the lack of adequate funding. Legislation at the Federal level may help eventually, but nothing will replace individual efforts. We must sell our programs and the value of trees at all levels. The Global ReLeaf program excites me because it is one that we should all be able to be active with—from the municipal, commercial and utility members, to the AREA, student and nonaffiliated members. We can all gain by participating. This gives us the opportunity to think globally and act locally.

A great deal of innovative thinking may be required as we attempt to find ways to stretch the already tight budgets. We may need to cooperate and share equipment, facilities, services, expertise. The Chicago area cities have already shown us the way.

Better planting is going to be necessary in the future. Plantings need to allow room for trees to grow and mature. Much research needs to be accomplished to help trees survive better in our inhospitable environment. The ISA Research Trust is helping to insure that the necessary research is being addressed. We continue to learn more about the urban forest and how it is intricately related to broader global environmental issues. Many things are being done well, but there is still much room for improvement. We still need to know more about the current conditions, and even numbers, in many cities. Many potential tree spaces remain to be filled with appropriately diversified trees. Funding continues to be a serious problem, but there seems to be a public awareness that trees are an important resource in urban areas.

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ABSTRACTS

WHITLOW, T.H., N.S. BASSUK, D.A. RAKOW and T.G. RANNEY. 1989. **Choosing ornamental trees for dry urban sites.** Grounds Maintenance 24(4):20, 22-25, 129.

In this article, we discuss factors that make a site dry, ways in which trees cope with dryness, and some less common species adapted to dry conditions. The focus will be on urban trees in the northeastern and north central United States. This is not to slight the rest of the country, but rather to acknowledge that in arid regions, the landscape industry is used to selecting appropriate plant material and designing for irrigation. In the Northeast where rainfall is abundant and year around, tree water requirements are frequently neglected in landscape design. Furthermore, plant selection for drought-susceptible sites in the North is problematic, because species suited to arid regions typically lack the necessary cold hardiness.

HOLMES, F.W. 1988. **Winter injury to shade trees.** Arbor Age (11):28, 37.

During the harsh winter season, the trees are susceptible to injuries from many exterior forces. A late frost, after the tree begins leafing out in the spring, may cause the young foliage to turn black and die. Another winter-related injury is cambial death. It stems from attempts to grow trees at a latitude too far north. Root death occurs from deep cold, when there is an absence of adequate snow cover. Ring shake is a separation of two wood layers, resulting in a minor cold injury during the winter. The drying effect of cold can also be deadly. Many winter hazards are unavoidable, but proper care and a little preventative medicine will keep most of your trees healthy and strong throughout the year.