# PROBLEM SITES: AN OVERVIEW

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Trees growing in urban environments are subjected to conditions quite different from those of natural forests. An important consideration is that trees have their ecological and evolutionary origins in natural forests and woodlands. Highly useful insights for planting and caring for urban trees sometimes may come from observations of natural landscapes. Tattar (1983) has outlined a stress model wherein he proposes that a "forest-like" urban environment would provide conditions most conducive to good survivability and enduring health and vigor among planted urban trees. He does not suggest that re-creation of an actual forest is necessary or even possible. His point is that, ideally, the environment of a planted urban tree should be similar to that of a forest tree. His concern is that evenness of environmental conditions in the natural forest contrasts sharply with the environmental extremes often associated with urban planting sites and planted urban trees.

Tattar describes the qualities of a natural forest ecosystem in his Alpha Model. He outlines a situation with high urban tree stress in an Omega Model which notes such negatives as temperature and moisture extremes, nutrient imbalances, excessive people-pressure, no follow-up care, and careless selection of species. His Beta Model, a forest simulation scheme, emphasizes minimal urban stress and summarizes approaches to overcoming problems associated with urban trees: proper moisture and nutrient balances provided: temperature extremesmoderated; people-pressure minimized: proper planting and follow-up care for new trees: and selection of trees tolerant to urban stress. Tattar's tree-stress models offer a constructive rationale and specific guidelines for coping with problem sites of urban trees.

Problem planting sites are widespread in urban areas because of the inimical nature of so much of the substratum and the harsh microenvironment of situations dominated by brick and concrete. A major challenge of the urban tree planting site is to bring about favorableness andevenness of environmental conditions, both above-ground and below-ground. More realistically, the challenge is to avoid environmental extremes. Trees carry genetic makeup that has developed over the millenia in nature's laboratories -- the forest communities. The planted urban tree, carrying age-old genes, may have no special capacity to tolerate a whole set of man-made environmental adversities. Thus, confronting the challenge in still another way requires close and careful study of the natural landscape to see how nature handles things

(Ware, 1982).

The soil environment of the natural forest is sheltered, shaded, and environmentally modulated, i.e. fluctuations are softened and blunted. There is an annual. deposition of leaves, replenishing organic matter that in the process of decomposition improves soil porosity, releases nutrients, and acidifies the soil. Zimmerman and Brown (1971) focus on the importance of the surficial soil in stating that "contrary to what many laymen believe, the bulk of the root system of most trees growing on medium-textured soils (loams and clays) is within three feet of the surface. The majority of the smaller absorbing roots lie in the upper six inches of forest soil." The commonly held notion that trees have taproots is mostly a fallacy. Perry (1982) emphatically and instructively details the vital functions of extensive spreading systems of tree roots in the surface meter of soil. The importance of providing roots of transplanted trees with ample spreading space in a favorable medium is a valuable lesson gained from observing growth patterns of root systems of trees of natural forest.

Preserving a natural and undisturbed soil system wherever possible is greatly desirable for planting trees in urban open spaces. The activities of multitudinous soil organisms have favorably conditioned the soil as a medium for root growth. An associated phenomenon is the aggregation of mineral particles into structural units that facilitate the movement of water and oxygen, both vital to root health and growth. The simultaneous availability of both water and oxygen is a special condition usually present in naturally developed soil, but often lacking in urban tree planting sites.

Substrata comprised of "fill" material have little of the porosity associated with undisturbed soils with their valuable organic matter and mineral aggregates. In fill soil, there is poor regulation of moisture, poor gaseous diffusion, physical impeding of root growth, and markedly fluctuating surface temperatures. Compaction of substrata is exceedingly common in urban areas. In addition to foot traffic, vehicular vibration may contribute to compaction. Prolonged retention of moisture may lead to anaerobic conditions and accumulation of toxic compounds, inhibitory or even lethal to roots (Craul 1982).

Urban soils are often difficult media into which to transplant trees. The amelioration of conditions for accommodating root systems is often not sufficiently effective. The roots of transplanted balled and burlapped trees may not readily enter the surrounding dense soil. There are actually two interfaces which roots must grow across to leave the root ball and enter the surrounding existing soil: rootball/backfill and backfill/existing soil. The frequently observed tendencyforrootstoproliferate within soil-root balls rather than to grow out of the balls, reveals an urgent need for better understanding of root growth patterns following transplanting.

Watson and Himelick (1983) found only a small amount of total root system present in the soil-root ball of transplanted trees. They stress the importance of rapid regeneration of rootlets from calluses, formed at severed root ends. Rapid proliferation of rootlets must occur if there is to be sufficient rootlet/soil contact to survive environmental vagaries and transpiration stresses of the first year. Transplanted trees undergo severe physiological shock because their capacity for water absorption is greatly diminished while transpiration demands continue (Kozlowski and Davies, 1975). The challenge is to induce rapid proliferation into a medium where restoration of a favorable root/crown ratio can develop before a stress event occurs. The more extensive the homogeneous medium surrounding the root ball, the greater the conduciveness for establishment of stabilizing new roots.

Providing an extensive volume of backfill is often regarded as impractical or as too expensive. The inducement of roots is most effective in the upper six inches where oxygen is adequate. Thus, the depth of the outer backfill material need not be very deep. Application of mulch assures adequate and uniform moisture in the broad backfill area. The basic task is to induce rapid lateral spread of roots to assure establishment and survival. Development of deeper roots can come later.

Sidewalk soil pits are extraordinarily hostile places for planting trees. Survivability of trees is generally low and life expectancy is poor. Dense soil, poor drainage, and root confinement are three constraints that are difficult to overcome. The need for rapid lateral growth of new roots is not accommodated. An alternative planting and management procedure is to plant groups of trees in large planter boxes containing a sufficient volume of soil to permit shared root space. An important advantage of the large planter box is the opportunity for facilitating drainage which is usually difficult or impossible to do in the sidewalk soil pit. Indeed, drowning of roots is a serious problem in sidewalk soil pits. A problem involving soil wetness is impairment of springtime root development, making summer transpiration stress more lethal.

There are some modifications to the concept of the sidewalk soil pit that may help to prolong the lives of sidewalk pit trees. Elongate rectangular soil pits provide greater rooting space, but only to a degree. Continuous brick strips next to the curb between pits permit root permeation under a brick "mulch". However, these superficial roots are quite vulnerable to dehydration. Too often the walls of soil pits do not permit an escape of root systems. Providing extensive soil volume and rooting space in planters below sidewalk level permits trees to grow larger and live longer. Sidewalk sections may be lifted to gain access to planters. Plate-like metal sidewalk substitutes may sometimes be seen. Most planter trees are in effect large bonsai-like plants with their viable future linked to slow growth and periodic reduction in number of branchlets or amount of foliage.

Flatness of terrain often produces drainage interference in urban areas, especially when drainage patterns that cross green spaces are interrupted by sidewalks, curbs, service drives, and other kinds of inconspicuous barriers. Prolonged periods of springtime soil wetness in flat areas often are not perceived as detrimental to tree growth until dieback and decline are evident. The planting of trees on low berms and mounds solves some of these wetness problems of flat places. However, care must be taken not to produce a barrier interface where added berm soil meets the original flat surface. The soil material in mounds or berms provides excellent horizontally spacious accommodation for laterally spreading root systems. Drainage and aeration are both generally favorable for root growth in mounds and berms.

The constraints of compacted, clayey, and periodically saturated soil necessitate the creating of favorable root-growing conditions in the upper six to twelve inches. The preemption of this zone by vigorously competitive grass compels trees to produce roots at greater depths where periodic episodes of wetness may be debilitative or destructive to root systems. Competitive grass may also intercept much of the rain that falls as summer showers, worsening the stress of high transpiration.

Ascertaining soil-environment conditions of urban trees is a challenge needing more resourcefulness. Direct examination of an elongate core obtained by use of a soil probe, may reveal contrasts in soil make-up. The core-hole provides convenient access for vertical temperature measurements. The soil core provides good samples for determining pH and salinity levels.

An axiom that has great significance for urban tree selection, planting, and management is that "urbanization leads to alkalinization". Concrete surfaces tend to alkalinize the rainwater that runs over them. Soil pH levels commonly are 7.5 to 8.0 in downtown areas. Mineral nutrient uptake of most trees is optimal at pH levels between 6.0 and 7.0. Chlorosis (yellowing of leaves) is commonly seen in urban trees. There are certain species called calciphytes that tolerate alkaline soils. Use of more calciphytes in urban plantings would contribute toward greater survivability (Ware, 1984).

There is a whole set of above-ground problems, challenges, and opportunities related tourbantree planting sites. Leaf-scorch on foliage on the street side of trees indicates vehicle-created transpiration stress. Excessive heat from asphalt, wind tunnel effects, and air pollution are additional adversities. Salt deposition on both twigs and soil is also a serious problem. Abrasion and damage to trees by people and vehicles are serious detriments. All of these factors enter into proper selection and modification of tree planting sites.

Ameliorating the conditions of problem sites for urban trees is part of a dual challenge. The term "problem site" implies adversities that must also be confronted in the selection and use of tree species that can best cope with difficult sites. Selecting stress-resistant tree species and modifying planting sites to accommodate the trees more favorably, are procedures that go hand-in-hand. Certain general qualities of stress-tolerant trees should be sought. High genetic root-top ratio is a desirable quality: leathery, thick, and highly cutinized leaves aregenerally more stress-tolerant. Appropriate geographic origin is also important. The concept of provenance should be given serious attention in the selection of trees for urban planting.

The selection of the right tree for the right place too often rests with considerationsthatdonotattachenoughimportance to survivability of the tree. Lists of aesthetically desirable trees provide little basis for selectingtreeswithgood survivability. However, attractive selections can be made from lists of rugged, durable, and ecologically appropriate trees.

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