Are Trees long lived?

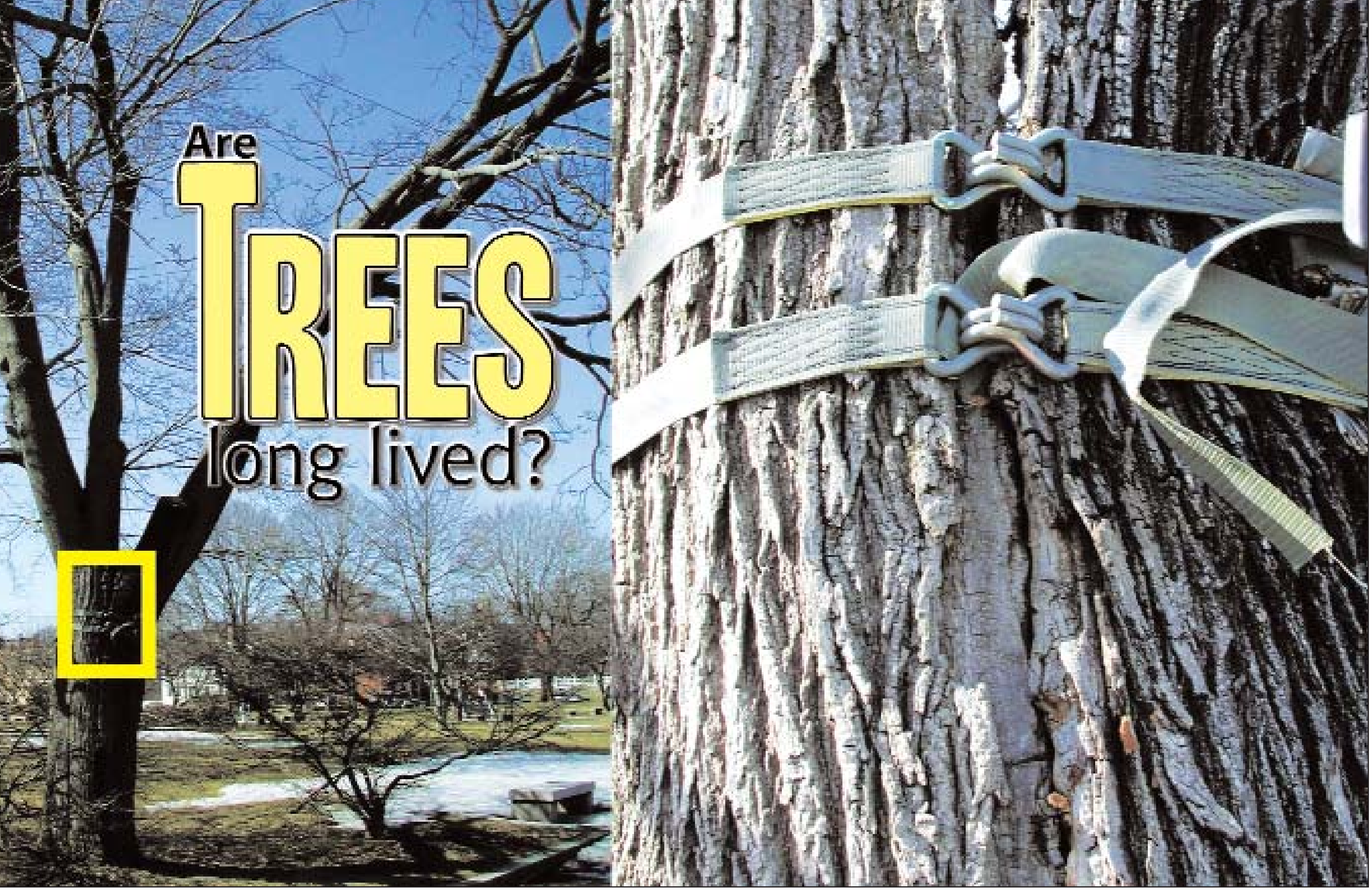

Fig. 2. We sometimes "buy time" with short-term answers (right, foreground) to long-term problems (left, background).

By Kevin T. Smith, Ph.D.

Trees and tree care can capture the best of people's motivations and intentions. Trees are living memorials that help communities heal at sites of national tragedy, such as Oklahoma City and the World Trade Center. We mark the places of important historical events by the trees that grew nearby even if the original tree, such as the Charter Oak in Connecticut or the Wye Oak in Maryland, has been lost.

In a more day-to-day setting, we buy trees and tree care to enhance property values as well as our quality of life. Perhaps less sustainably, we plant moisture-loving trees with irrigation systems in arid areas as statements of affluence and power.

The ancient and veteran trees we enjoy today developed in wild unmanaged forests of the past, in protected forest preserves and on agricultural lands. As communities spread, some of these trees have become part of our community forest. Society also has set aside some forests to remain wild and to maintain ancient trees in their natural habitat. We hope that the current veteran and ancient trees will remain with us for many more years. Do the next generation of ancient and veteran landscape trees have roots in our cities and communities today?

The myth of long-lived trees

Dr. Alex Shigo's first entry in his book "100 Tree Myths" is the myth that "trees are so big and tough nothing can injure them." The passage continues with the observation that many trees die because of abuse from human activity. Undoubtedly, this is true, but what is the context for tree survival in the forest? For students and teachers of tree biology, the answer to that simple question is not so simple! Even such an obvious statement that "trees are long-lived" is not quite right. That statement is based on a tautology, related to the identity principle in arithmetic, that 1 = 1. Tautologies are true, but not very useful. Sure, long-lived trees are long lived. In my dendrochronology research, I've had the pleasure to work with trees that are more than several centuries old. But are trees usually long-lived in natural or community forests?

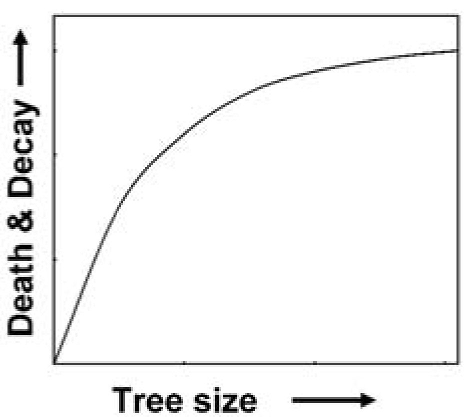

Fig. 1. As tree size increases in the forest, so does the proportion of trees that die and decay. All figures/photos courtesy of Kevin T. Smith and Kenneth R. Dudzik.

Foresters develop tables that contain the numbers and sizes of trees in fully stocked forest stands. Although the specific numbers vary with species and location, the general trend is that the number of trees in an area decreases as tree size increases. We can rearrange those same numbers to show that as trees increase in size and age, the proportion of trees that die and decay also increases. The reminder is that all trees die and that most trees die and decay when they are small. I say "die and decay" because in the forest, death is not the end of the natural history of a tree. Healthy forests depend on competition and mortality of some individual trees to strengthen the genetic basis of survivors in the forest. Forests also depend on decay to improve soil condition and fertility.

It seems to be human nature to want to know about the largest or oldest of trees. In addition to sheer beauty and majesty, the engineering challenges to maintain a large, complex tree structure are truly awesome. To attain great age and size requires the capture of huge amounts of energy, the movement of much water, essential elements, food, as well as plenty of good luck. Society honors large specimen trees through state champion programs, native tree societies, and advocacy groups. Although I love large and old trees, most of my professional interest is in the "normal" range of size and age, what we encounter most often in our local urban and community forests. These are trees that we can influence most readily, for better or for worse.

For years we've heard that the average life span of a street or park tree is less than 20 years. I've heard that so often, give or take a few years, that I had come to think of it as an urban legend. But unlike most urban legends, I think we can point to a specific source that may not be the first description of the short lifespan of community trees, but is one that did reach a lot of people in arboriculture.

Back in 1976, the first Metropolitan Tree Improvement Alliance conference was held in Lanham, Md. The presented papers (published in 1978 and available online) open with Prof. Thomas O. Perry's contribution on tree size and survival rates. Perry observed that the half-life of a landscape planting was less than 30 years where tree conditions were favorable and less than 15-20 years along city streets. His

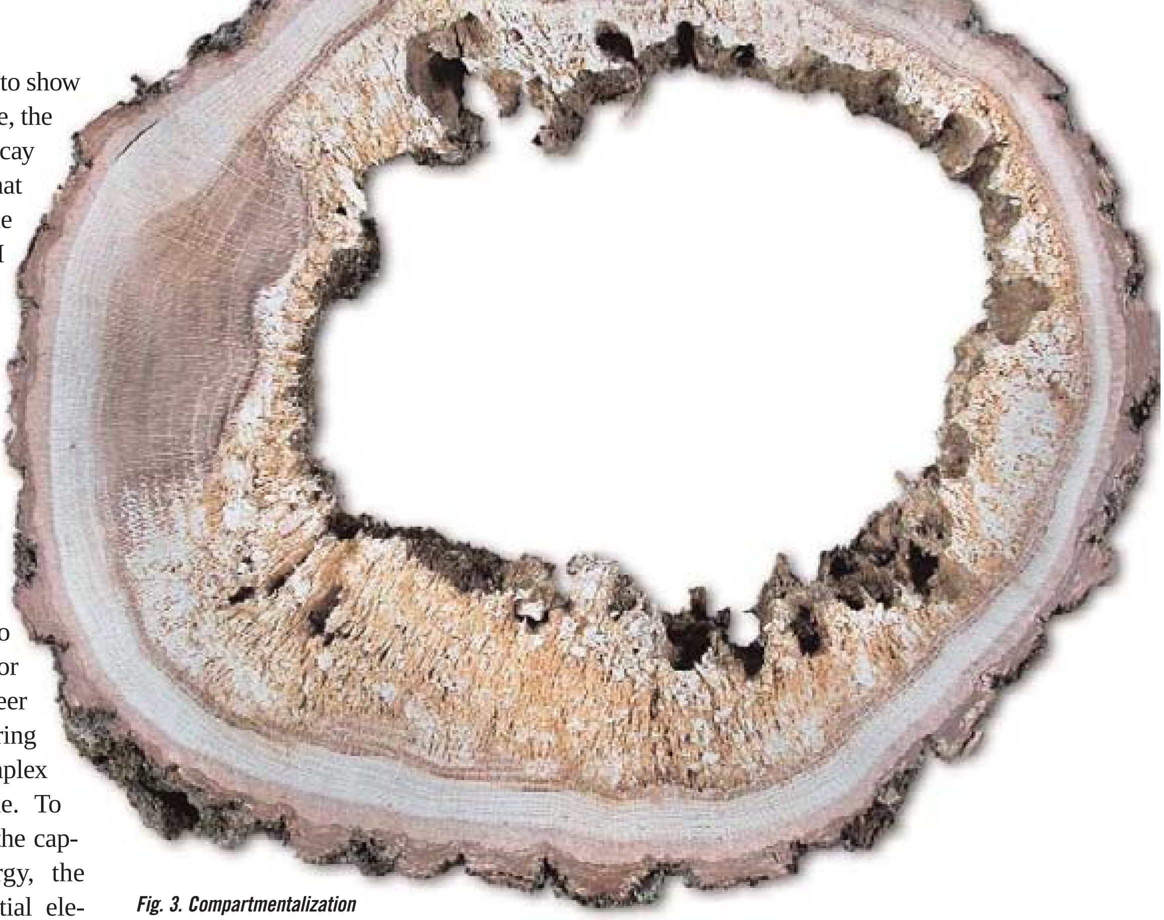

Fig. 3. Compartmentalization that keeps trees alive can also add to risk of failure.

observations were based on counting tree-rings of stumps after tree removal. His results were consistent across geographic regions and types of landscape. More recent observers report much the same findings. Not very hopeful for the success of future veteran landscape trees!

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Tree success and failure

In nature, tree success is to survive and spread. The strategies to do so are programmed or hard-wired into the genetic code and expressed as tree structure and function. "Survival" can mean regeneration from stump or root sprouts as well as survival of the individual stem. "Spread" can mean the development of a full, spreading crown that captures the sun's energy over a wide area, but can also mean spreading from root sprouts and seedlings. As land managers and arborists, we rely on the strong drive to survive for individual stems, but may get frustrated at the programming of some trees to sprout and spread where we don't want them! This is part of the problem posed by invasive plants that are so effective at spreading that they threaten to replace more desirable native trees.

In the urban and community forest, we sometimes inherit the care of trees that bear witness to improper practices in the past. Even though industry-wide standards have improved, our street and park trees contain individuals that have been topped or had branches removed with flush cuts. Poor form, such as tight v-crotches that could have been avoided or corrected early in the life, is costly to correct with increased tree size. Treatment options, including removal, are considered along with the risks and consequences of failure. Sometimes none

Fig. 4. Inappropriate wraps and hardware work against basic tree biology.

of the available options are particularly appealing. Proper cabling and bracing can be legitimate options that "buy some time." However, these remedies are generally expensive to apply and require ongoing commitment to monitor performance and the effects of treatment.

What can be especially discouraging is the failure of a large, recent planting. When young, rapidly growing trees are incorrectly planted, whole installations can die in a single season. It may take five years or so, but being planted too deeply or with inadequately removed wire or nylon ties from the planting ball kills trees. With all of the accumulated practical experience available, this still happens all too often. Preventing these problems begins with an understanding of the most basic principle of tree biology – that trees are alive. The vascular cambium that forms new xylem (which matures into wood) and new phloem (inner bark) needs to expand outward. Constriction from inappropriate wraps and hardware that interfere with this growth will girdle and can kill the tree.

Strategies for tree and forest health

In the natural forest, success depends on the death and decay of trees to provide soil organic matter and to release stored essential elements. The energy contained in the organic matter also fuels the distribution of elements across the forest floor and between layers of forest soil. The decay process frequently begins in the living tree. Dr. Shigo's development of the compartmentalization concept showed that a tree void or cavity represented success and not failure in the defense and protection system of trees. In this concept, the opportunity for wood decay starts with mechanical injury to the stem, branch or root. The cause of wounding could be natural shedding of branches, storm injury or human activity. Some pathogens, such as the fungi that cause Armillaria root disease, can directly kill living root tissues, essentially making their own wounds to gain entry to the tree. These pathogens and others that cause root and stem decay are good opportunists and will infect man-made injuries as well.

Fig. 5. Mycorrhizal fungi are part of the soil community that maintains long-term health of trees and soil.

Compartmentalization resists the spread of infection and protects the vascular cambium by forming boundaries and barriers. Successful compartmentalization means that the wood infection occurs in the smallest possible volume of wood. This minimizes the exposure of wood to the decay process and maximizes the volume of healthy sapwood for energy storage and active response to future injury and infection. The vascular cambium can continue to divide and to move away from the site of injury and resulting infection.

Although aggressive pathogens in time can overcome compartmentalization boundaries, the production of new wood moves the nutrient-rich vascular cambium and phloem away from infection. This new growth extends the life of the tree, while the decay organisms break down the wood within the compartmentalization boundaries.

To the extent that compartmentalization enables the tree to survive, to grow new wood and other tissues – and to keep upright – compartmentalization is successful. However, if infected with an aggressive wood decay pathogen and given sufficient time, the production of new wood to the outside of the stem will not keep pace with wood lost to decay. This increases the risk of structural failure when the compromised stem is loaded by wind, ice or other mechanical forces. Compartmentalization contributes to tree survival yet also can contribute to tree hazard by extending "service life" during the period of increased weakness of the tree structure.

Recent research by Francis Schwarze, Ph.D., and colleagues has extended our understanding about the different strategies that even closely related fungi have to overcome compartmentalization boundaries. Many tree workers in the U.S. recognize the artist's conk, Ganoderma applanatum, on dead stumps and trees in severe decline. The artist's conk also occurs in northern Europe as does another member of the genus, G. adspersum. Both fungi decay wood within the compartmentalization boundaries formed by the living tree. However, Dr. Schwarze and colleagues have shown that G. adspersum can overcome the compartmentalization boundaries formed in wood present at the timing of wounding. As our sources of information become more international, we need to recognize that, although the basic patterns of tree biology and needs for tree care are similar, the international community may have different organisms of concern than we have here in the U.S.

Wood decay and soil fertility

The wood decay process in living trees, downed wood and shed branches and foliage is an important link that maintains fertility of the natural forest. We teach small children that the decomposers cycle elements locked in dead organisms and make them available to living organisms. This is true, but incomplete. In addition to the release of stored elements, the progressive breakdown of wood by fungi and other organisms fuel the communities of microorganisms that fix nitrogen from the air into fertilizer, that change the chemistry of compounds into forms that trees can use, and that move mineral elements to roots.

A chief reason that some urban and community tree plantings require fertilization is that we remove the fuel and elements contained in downed wood and shed leaves, primarily for aesthetic and safety reasons. We can understand some removals are necessary for society and perhaps are a good part of the business of tree care. But this helps to explain why natural forests don't require fertilization to maintain health. In a sense, health is maintained by the death and decay of others. This relationship between the tree and the community of decay fungi can last for decades until the fungi and associated organisms in the "clean up" crew of decomposers do their work.

In both the wild and the community forest, long-term survival is the exception rather than the rule. We can explain away mortality rates in the native forest as a consequence of competition. For community forests, we have added stresses of soil compaction, mechanical injury from construction and from landscape care, and treatments applied with little understanding or respect for the biology that determines tree survival. Individual tree care practitioners or industry groups have an opportunity to decide which actions are based on short-term expectations of tree survival and which are to support the ancient veterans of the future.

Kevin Smith, Ph.D., is a plant physiologist and project leader for the USDA Forest Service in Durham, New Hampshire. This article was taken from his presentation, "Are We Choosing Disposable Landscapes," at TCI EXPO 2008 in Milwaukee. He will present on "Tree Response to Climate Change" at TCI EXPO 2009 in Baltimore this November.