# The Ecology and Economics of Elm Replacement in Harvard Yard

*Peter Del Tredici*

**Two new Dutch elm disease-tolerant American elms have rekindled interest in restoring the species to the landscapes it once dominated.**

These new selections of *Ulmus americana*—'New Harmony' and 'Valley Forge', recently introduced by the United States National Arboretum—represent an important horticultural breakthrough,[1] but some basic biological issues should be considered before any new plantings of the American elm are undertaken. The purpose of this article is to articulate these questions in economic as well as ecological terms in order to facilitate the decision-making process that many landscape architects, designers, and town managers now face concerning the use of American elms in historic landscapes.

### The American Elm in History

The first question that should be asked is why this tree came to be so widely planted across eastern and central North America in the first place. The explanation can be found in the horticultural literature of the 1800s, particularly in a beautiful book by Lorin Dame and Henry Brooks that was published in 1890, *Typical Elms and Other Trees of Massachusetts*.[2] Profusely illustrated and written long before Dutch elm disease appeared in North America, it serves as a portrait of the American elm at the pinnacle of its landscape dominance. The authors made many important contributions to our knowledge of the American elm, but most significant is their documentation of a key fact: that the huge elms of the past reached their great size by virtue of rapid growth rate, rather than by great age. Other writers who described the American elm in the nineteenth century include F. A. Michaux (1819), A. J. Downing (1841), D. J. Browne (1846), F. J. Scott (1870), G. B. Emerson (1875), and C. S. Sargent (1890).[3] These authors make it clear that the American elm was widely planted for a number of reasons, only one of which was its great size and beauty. Other, more pragmatic reasons gleaned from the literature of the period can be summarized as follows:

- The American elm, a native species, was widely distributed throughout eastern and central North America, typically growing on moist bottomland or along disturbed roadsides.
- It was so easy to transplant that it could literally be ripped out of swamps and planted along roadways.
- It recovered well from the heavy pruning it received following these careless transplanting practices.
- It was highly adaptable, growing equally well on wet or dry sites.
- It grew very rapidly, averaging about a half-inch increase in caliper per year and reaching two to three feet in diameter within seventy years. Shade was in short supply in the nineteenth century, and the American elm provided it more quickly than any other tree.
- It shed its lower branches naturally, making it well suited for locations along heavily trafficked city streets and country roads.

### Dutch Elm Disease

The Dutch elm disease fungus, along with its dispersal agent, the European elm-bark beetle, arrived in North America in 1930, hidden under the bark of European elm burl-logs that had


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been shipped into the United States for making veneer.[4] The disease spread so rapidly and killed American elms so quickly that it seemed at first that the species was headed for extinction. Fortunately, this prediction has not come to pass. The species still thrives as a wild tree in wet woods and along streambanks throughout eastern North America.[5] As a landscape plant, however, the American elm is close to extinction. The grand old specimens, four to five feet in diameter, that once graced virtually every town common in New England have been replaced by trees that seldom reach more than eighteen inches across before succumbing to DED or some other disease.

Since the 1960s, there has been considerable publicity about various efforts to "save" or to "bring back" the American elm. Long-term approaches have involved either selecting DED-tolerant American elm cultivars or hybridizing American elm with other elm species that are DED-resistant. In contrast, short-term approaches focus on preserving existing specimens by spraying for the beetle, injecting infected trees with fungicides, and removing diseased limbs as quickly as possible. While these treatments have saved individual trees for up to twenty years, they are at best temporary solutions; the inevitable infirmities of old age are already catching up with older specimens.

*American elms have long been valued for their exceptional growth rate. This 'Princeton' elm grew more than two meters in a single year. Jack Alexander, Arnold Arboretum propagator, points to the start of the current year's growth.*

### Case Study: The Harvard Elms

The American elm has been the mainstay of the Harvard Yard landscape for well over a hundred years. The trees have faced many threats during this time, but none has been as serious as the introduction of Dutch elm disease.[6] In 1979, when Harvard University began to implement an integrated elm protection program, there were 285 elms on campus. Most of them were American elms, but a number of English and European elms of uncertain identity were also mixed in. Most of the trees were about seventy or eighty years old when the protection program began. By 1994, after fifteen years of treatment, there remained only 165 elms, a mortality rate of 42 percent. Detailed figures do not exist, but the average cost of the total protection program for the Harvard Yard elms over the period is estimated at $25,000 a year, broken down roughly as follows:

- $14,000 for two sprays each year (one dormant oil and one foliage spray)
- $3,000 for fungicide injection each year
- $3,000 for fertilization every third year
- $5,000–$10,000 for pruning and removals

Over the fifteen-year period the total amount spent on the elms was approximately $375,000, or $100 per tree per year, in spite of which, mortality was at 42 percent after fifteen years. By extending these figures out, one can calculate the cost of elm maintenance over twenty years at roughly $500,000, with mortality approach-

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Ulmus americana *'Princeton', a Dutch elm disease-tolerant American elm cultivar, has been growing on the northeast slope of Bussey Hill since 1935*

ing 50 percent. By comparison, the annual cost for maintaining non-elm trees in the Yard is approximately $20 a tree.

**Replacement Costs**

In 1994 an elm replacement program was initiated.[7] The cost of planting 200 new trees in the Yard, most of them four to eight inches in caliper and ten to twenty feet tall, was $470,000, or $2,350 per tree, including a one-year maintenance contract and guarantee.

Essentially, the numbers show that the cost of planting 200 new trees was roughly equal to the cost of maintaining 285 elms for twenty years, of which only half will still be alive and the other half in a state of decline at the end of twenty years. To put it another way, twenty years of maintaining one large elm with only a 50-percent chance of survival costs the same as planting one new four-to-eight-inch caliper tree.

There is no absolute answer to the question of how much one should invest in an elm protection program, and in any case, the question should not be decided purely on an economic basis. Elm protection programs cannot save a tree forever, and in anticipation of the death of the elms, such programs should always be undertaken in conjunction with a program of planting other species of trees. It is clear that the high density of American elms that was seen in many cities and towns during the first third of the twentieth century should not be recreated.[8] Indeed, it was this high density that allowed the elm-bark beetle population to build up rapidly, leading to the epidemic spread of DED. One sees more elms surviving these days than in the past, not because trees are more tolerant of Dutch elm disease than before, but because the reduced elm population has resulted in lower elm-bark beetle populations. This in turn allows more elms to escape detection by their predators. Planting new trees of different species are

*Just months after this photograph was taken, this hundred-year-old American elm, one of the last still standing on Boston's Commonwealth Avenue Mall, succumbed to a heavy wet snow that brought it crashing down onto cars and into townhouse windows.*

*The remnants of an allée of American elms tower over replacement plantings of* Zelkova serrata *on the grounds of Phillips-Exeter Academy in Andover, Massachusetts The zelkova has many merits, but neither in scale nor stature does it resemble the American elm*

an investment in the future that softens the blow when a big elm dies, as it inevitably does.

### Achieving Diversity

Unfortunately very few, if any, trees possess the combination of graceful form and great size of the American elm. The honey locust, *Gleditsia triacanthos*, comes about as close as any tree, but it grows much more slowly. *Zelkova serrata* has roughly the same shape but is much smaller. As Koller and Weaver point out, there is no perfect replacement for the American elm.[9] The key to successful substitution is to choose species with the same landscape impact or stature, regardless of whether they possess the American elm's structure.

Within the genus *Ulmus*, there are several potential candidates, but none are without some drawback. The ubiquitous Siberian elm *(U. pumila)*, for example, is highly resistant to DED but is very messy and graceless in form. The lacebark elm *(U. parviflora)* is a handsome tree, but much smaller than its American cousin. Some of the more recent hybrid elms (involving *U. davidiana, japonica,* and *wilsoniana*), may eventually prove to be excellent replacements, but they have not yet been thoroughly tested under landscape conditions.[10]

It must also be remembered that DED is only one of several diseases that kill American elms.[11] In particular, phloem necrosis and elm yellows can be lethal to many of the cultivars that have been selected for their tolerance to DED.[12] And the elm-leaf beetle, along with a host of other insects, had been killing elms long before DED arrived on the scene. If the American elm is to make a comeback in the modern American landscape—either as a hybrid or as a disease-tolerant selection—it should be used on an equal footing with other species, never as the predominant species in the landscape.

Another approach to replacing American

elms involves working within a single genus or family, which allows one to approach uniformity and diversity simultaneously. In the Tercentenary Theater part of Harvard Yard, for example, a grouping of legumes including *Cladrastis, Gleditsia, Gymnocladus,* and *Styphnolobium* (formerly *Sophora*), all share a characteristic arching trunk and flat-topped crown, but clearly differ in other aspects of their habit. One can also group different oak species to achieve a measure of uniformity amidst diversity. In the oldest section of the Yard, a grouping of oak species includes *Quercus rubra, palustris, phellos, coccinea, alba, bicolor,* and *acutissima.*

The advantages of increased species diversity can be summarized as follows:

- It offers a measure of protection against an epidemic spread of insects or of fungal and bacterial diseases.
- It allows one to match different microclimates on the site with the most appropriate species.
- It provides greater variation in flower and foliage displays, making a walk across campus a more interesting and potentially a more educational experience.

## Conclusion

The desire to restore the American elm to its former status as the primary street tree in the East is very strong. But if "restoring" a given historic landscape means replanting the American elm—or any of its disease-tolerant selections or hybrids—at the density it occupied historically, then it is a mistake. In the popular literature on elms, the unspoken assumption seems to be that if we could only conquer Dutch elm disease, then we could easily recreate the grand, elm-lined streets of the past. This idea is biologically unsound. Because of the dynamic nature of the interaction between host and predator, "disease tolerance" is always a relative phenomenon, not a fixed genetic trait; total immunity is unattainable. Historical accuracy and aesthetic tastes notwithstanding, it is in no one's interest to bring the American elm back to its former position of landscape preeminence.

**Endnotes**

[1] United States National Arboretum Plant Introduction Announcement, *Ulmus americana* 'Valley Forge' and 'New Harmony' (January, 1997).

[2] An excerpt from *Typical Elms and Other Trees* appeared in *Arnoldia* (1982) 42(2): 49–59.

[3] F. A. Michaux, "*Ulmus americana,*" in *The North American Sylva,* vol. 3, tr. by A. L. Hillhouse (Paris and Philadelphia, 1819); A. J Downing, *A Treatise on the Theory and Practice of Landscape Gardening,* 9th ed. (NY: Orange Judd, 1873); D J. Browne, *Trees of America* (NY. Harper & Bros, 1846); F J. Scott, *The Art of Beautifying Suburban Home Grounds of Small Extent* (NY: D. Appleton, 1870); G. B. Emerson, *A Report on the Trees and Shrubs Growing Naturally in the Forests of Massachusetts,* 2nd ed. (Boston: Little Brown, 1875). C. S. Sargent, "*Ulmus americana*", in *Silva of North America,* vol. 7 (Boston: Houghton Mifflin, 1890).

[4] Berton Roueché, "Profiles: A great green cloud," *The New Yorker* (July 15, 1961), 35–53; Donald C. Peattie, *A Natural History of Trees,* 2nd ed (Boston: Houghton-Mifflin, 1964).

[5] R. M. Burns and B. H. Honkala, eds., "*Ulmus americana,*" *Silvics of North America,* vol. 2, Hardwoods (USDA Forest Service Agriculture Handbook 654, 1990).

[6] J. Shaw, "Every tree doomed," *Harvard Magazine* (1994) 96(4): 46–53.

[7] Ibid; M. Van Valkenburgh and P. Del Tredici, "Restoring the Harvard Yard Landscape," *Arnoldia* (1994) 54(1): 2–11.

[8] J. O. Dawson and M. A. Khawaja, "Change in street-tree composition of two Urbana, Illinois, neighborhoods after fifty years: 1932–1982," *Journal of Arboriculture* (1985) 11(11): 344–348.

[9] G. L. Koller and R. E. Weaver, Jr., "Replacing the American Elm: Twelve Stately Trees," *Arnoldia* (1982) 42(2): 88–100.

[10] Michael Dirr, *Manual of Woody Landscape Plants,* 4th ed. (Champaign, IL Stipes, 1990); F. S. Santamour, Jr , and S. E. Bentz, "Updated checklist of elm *(Ulmus)* cultivars for use in North America, *Journal of Arboriculture* (1995) 21(3): 122–131; A. M. Townsend et al., "Variation in response of selected American elm clones to *Ophiostoma ulmi,*" *Journal of Environmental Horticulture* (1995) 13(3): 126–128; G. Ware, "New elms for urban landscapes," *Morton Arboretum Quarterly* (1995) 31(1). 1–9.

[11] Sinclair et al , *Diseases of Trees and Shrubs* (Ithaca, NY: Cornell University Press, 1987).

[12] Santamour and Bentz, op cit.

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