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The Role of Horticulture in a Changing World

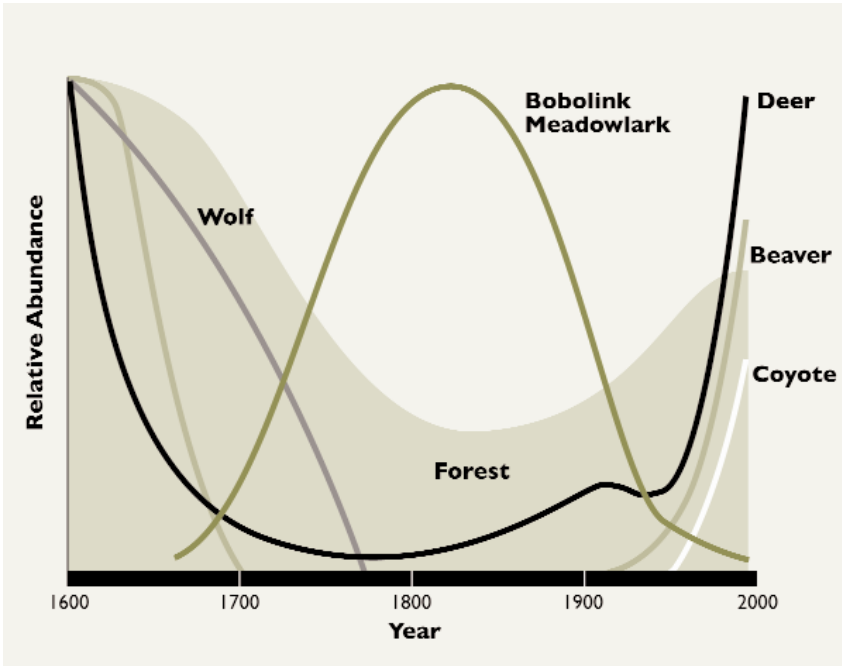
Peter Del Tredici

It's easy to enumerate hot-button issues in contemporary American culture: gun control, abortion, globalization, terrorism, and immigration reform are just a few. One thing that the debates about these issues have in common is that they are highly polarized, with neither side paying much attention to what the other is saying. Another is that they often have an overarching moralistic tone that pits good against evil, with little regard for facts. How our society will manage to move forward on such contentious issues remains to be seen.[1]

Within my own narrow field of expertise, plant ecology, the use of exotic versus native species in designed landscapes is an issue that seems to bring out the worst in people, not unlike the debates over gun control and abortion. As a representative of the Arnold Arboretum of Harvard University, I have served as a member of the Massachusetts Invasive Plant Advisory Group, a voluntary collaboration of nursery professionals, conservationists, botanists, land managers, and representatives from various government agencies that reports to the state's Office of Environmental Affairs. Over the course of the past three years, the group has produced a list of species that are invasive in "minimally managed" habitats and developed a strategic plan with recommendations for how to cope with the problem.

On the national scale, researchers have determined that invasive species, including plants, animals and microbes, are an ongoing threat to native ecosystems as well as to rare and endangered species and are the cause of economic losses totaling approximately $137 billion annually.[2] In 1999, President Clinton issued an executive order establishing a National Invasive Species Council to investigate the problem and develop a comprehensive plan for dealing with it.[3] The Council's report, which was issued in January 2001, strongly recommended a strategy that focused on the early detection of invasions followed by rapid response eradication on the ground.[4]

Implicit in the proposals that call for the control or eradication of invasive species is the assumption that the native vegetation will return to dominance once the invasive is removed, thereby restoring the "balance of nature." That's the theory; reality can be quite different. Land managers and others who have to deal with the invasive problem on the ground know that often as not the old invasive species comes back following removal—reproducing from root suckers, stump sprouts or seeds—or else a new invader moves in to replace the old one. Oftentimes the only thing that seems to turn this dynamic around is cutting down the invasives, treating them with herbicides, and planting native species in the gaps where the invasives once were. Following this, the site requires weeding invasives for an indefinite number of years, until the natives are big enough to hold their ground without human assistance.[5]



1. Changes in the relative abundance of selected animal species in Massachusetts over the past 400 years as a function of forest cover. Note that the wolf has been eliminated from the landscape, the beaver has been successfully reintroduced, and the coyote represents a new addition to the fauna. The rarest species, bobolink and meadow lark, are associated with open fields, which have been steadily diminishing since the mid-1800s (modified from Foster et al., 2002).

What's striking about this so-called restoration process, with its ongoing need for planting and weeding, is that it looks an awful lot like gardening. Call it what you will, but anyone who has ever worked in the garden knows that planting and weeding are endless tasks.[6] So the question becomes: Is "landscape restoration" really just gardening dressed up with jargon to simulate ecology, or is it based on scientific theories with testable hypotheses? To put it another way: Can we put the invasive species genie back in the bottle, or are we looking at a future in which nature as we know it becomes a cultivated entity?[7]

The answer to this question lies in an understanding of the concept of ecological succession, the term used to describe the change in the composition of plant and animal assemblages over time. In the good old days, before World War II, ecologists generally tended to view succession as an orderly process leading to the establishment of a "climax" or steady-state community that, in the absence of disturbance, was capable of maintaining itself indefinitely. I like to refer to this as the Disney version of ecology, stable and predictable, with all organisms living in perfect harmony. Following the war, a younger generation of ecologists began challenging this orthodox view, eventually formulating what is known as the theory of patch dynamics, which views natural disturbances as an integral part of a variable and unpredictable succession process.[8] The key concept here is that the nature, timing, and intensity of the disturbances are critical factors—together with climate and soil—in determining the composition of successive generations of vegetation. From the modern ecological perspective, the apparent stability of current plant associations is an illusion; the only certainty is that things will be substantially different within fifty years.[9]

When one broadens the definition of disturbance to include the effects of acid rain on the earth's surface and carbon dioxide enrichment on its atmosphere, it becomes clear that there is no place on the planet that has not experienced some level of disruption as a result of human activities.[10] The absurd position that global warming has not yet been "proven" is based on the assumption that people have the capacity to understand—at a detailed level—how the world's climate system actually works. From my perspective, the scariest thing about climate change is the uncertainty about how it will actually play out on the ground. When and if scientists get around to accurately predicting the effects of pumping massive amounts of carbon dioxide and nitrous oxide into the atmosphere, it will be far too late to do anything about it.

A cursory glance at the land-use history of New England, as documented by researchers at the Harvard Forest in

2. A dead American chestnut *(Castanea dentata)* in the town of Harvard, Massachusetts, photographed in 2002. The stump, which is thirty-one inches in diameter, was killed by the introduced chestnut blight between 1920 and 1930 (left). On the right is a "sprout-clump" of the same species as it now appears in the forests of eastern North America (right). Essentially the chestnut blight has diminished the role of the American chestnut from a canopy tree to an understory shrub. Photographs by P. Del Tredici

Petersham, Massachusetts, makes it clear that the scope of landscape transformation over the past three hundred years has been vast and its outcomes unanticipated and irreversible (Figure 1).[11] As such, these studies provide a picture not only of how the past has influenced the present, but also of how the landscapes of the Northeast are likely to change in the future. Unfortunately, this approach, which has been referred to as "stepping back to look forward,"[12] does not account for the fact that the scale and pace of today's environmental change far outstrips anything seen in the past.

One particularly problematic aspect of the restoration concept is its denial of the inevitability of ecological change. Implicit in much of the popular writing on the subject is the assumption that the plant and animal communities that existed in North America prior to European settlement can be returned to some semblance of original composition. The fact that the environmental conditions that led to the development of these pre-Columbian habitats no longer exist—and can never be recreated—does not seem to matter to strict restorationists, whose "faith-based" notions of restoration clearly have more to do

3. The common reed, *Phragmites australis,* growing in the Back Bay Fens of Boston, Massachusetts, was probably planted in the 1880s, during F. L. Olmsted's Muddy River restoration. Photo by P. Del Tredici

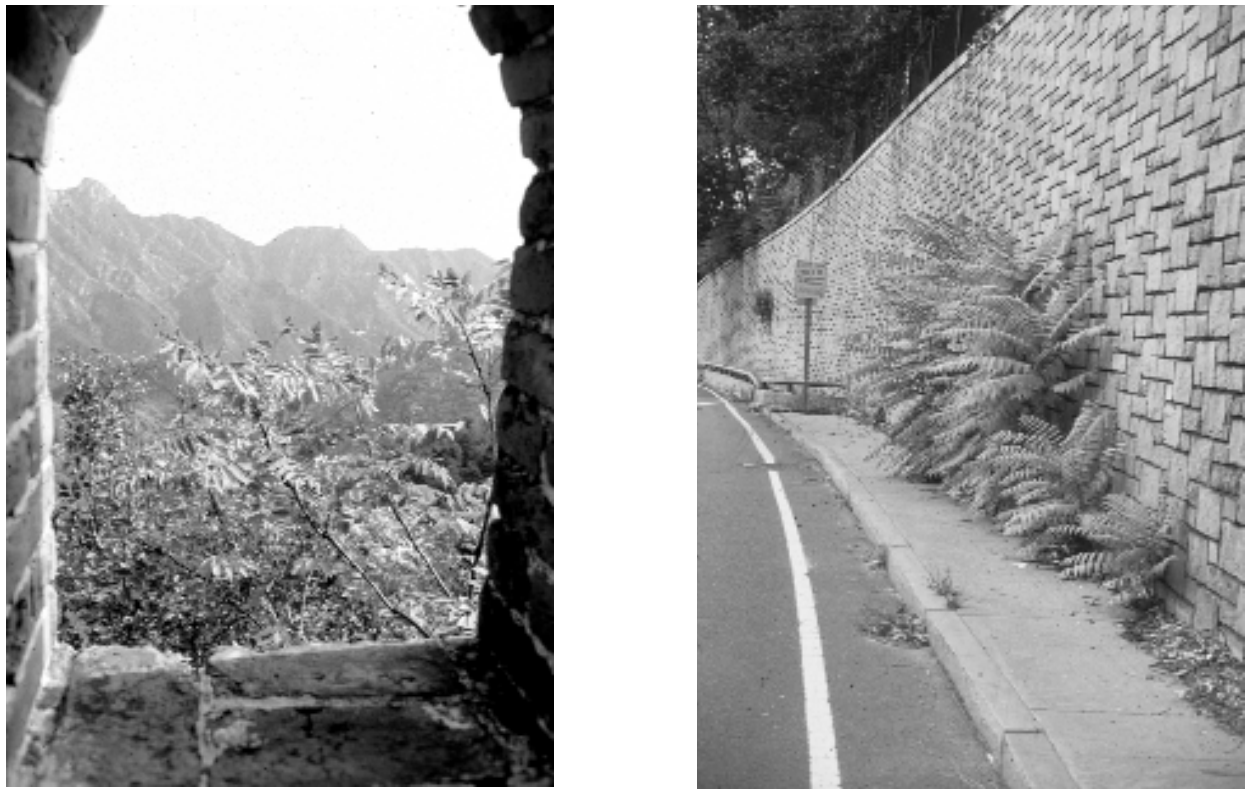
with ethical values than with ecological reality (Figure 2).

Experience from eastern North America clearly shows that even when the individual components of former ecosystems make successful comebacks, they tend to function differently than they did in the past because of irreversible changes in other parts of the ecosystem. This is best exemplified by the extensive herds of white-tailed deer (*Odocoileus virginianus*) that were formerly controlled by the hunting activities of Woodland Indians,[13] but today they roam the countryside selectively browsing plants they find palatable—both cultivated and wild—managing to annoy homeowners and alter long-established patterns of forest succession in the process.[14] The dynamic nature of interactions among people, plants, and animals in today's world are producing novel ecological associations with unpredictable consequences for all parties concerned.[15]

The concept of ecological restoration in an urban or suburban context is particularly problematic, given the abundance of pavement, road salt, heat buildup, air pollution, and soil compaction that characterize metropolitan centers. Indeed, the critical question facing landscape professionals is not what plants grew there in the past, but which ones will grow there in the future? Starting in the early 1800s and continuing through the present, plants from around the world have been brought together in our cities and suburbs in order to enhance their livability.[16] Like it or not, a relatively small percentage of these ornamental introductions have adapted well to the urban habitat and begun reproducing on their own. Regardless of the disparaging labels we apply to such "naturalized" species, they are actually performing significant ecological functions including water filtration, mineral cycling, and carbon fixation and storage.[17]

A good example of this is the common reed, *Phragmites australis*, which is native to Europe and central Asia, as well as to North America where it grows in brackish wetlands up and down the east coast, most dramatically in the meadowlands bordering the New Jersey Turnpike west of Manhattan (Figure 3). Although *Phragmites* is often portrayed as the ultimate invasive species because of its tendency to crowd out other vegetation, it is actually mitigating pollution by absorbing a great deal of the nitrogen and phosphorous that typically accumulates in disturbed wetlands.[18] From the functional perspective, the presence of *Phragmites* in this landscape can be viewed as a symptom of environmental degradation rather than as its cause. It turns out that many invasive plants have a similar kind of "Jekyll and Hyde" impact on the local ecology, pushing out some native species, while simultaneously providing food and shelter for a variety of native animals, especially pollinating insects and migrating birds.[19]

Regardless of how one feels about the unique assemblages of plants that populate our sprawling cities, they have become its de facto native vegetation. In a very real sense, the diversity and spontaneity of these new "immigrant" communities mirrors



4. The tree of Heaven, *Ailanthus altissima,* growing in its native habitat near the Great Wall of China (left); and the same species making itself at home along a roadway wall in Boston (right). Photos by P. Del Tredici

that of our own society (Figure 4). Indeed, the very same processes that have led to the globalization of the world economy—unfettered trade and travel among nations—have also resulted in the globalization of our environment.[20]

So what can landscape professionals, working on the ground, do to cope with the widespread environmental devastation and ecological uncertainty that have become such an integral part of the modern world? I have developed a practical, three-step approach that covers the construction, design, and maintenance of urban landscapes. The first step of my program is to acknowledge the fact that the heavy equipment used during the construction process inevitably compacts the surrounding "soil" to a density approaching concrete. Such compacted soils, with their low oxygen tensions, high bulk-density and impeded drainage,[21] are lethal to many landscape plants, especially native species that come from upland habitats. Without adequate remediation of the compaction and drainage problems that abound in urban landscapes, invasive species are pretty much the only plants that will survive.

My second suggestion is not to limit planting designs to a palette of native species that once grew on the site. Imposing such a limitation not only reduces the aesthetic possibilities for the landscape but also its overall adaptability to future environmental change. Instead, I propose that sustainability be the standard for deciding what to plant. According to my definition of this overused word, sustainable landscape plants are tolerant of the conditions that prevail on a given site; require minimal applications of pesticides, herbicides, or fertilizers to look good; have greater drought resistance and winter hardiness

than other plants; and, finally, they do not spread aggressively into surrounding natural areas. Landscapes that are designed with plants that fit this criteria—including both native and introduced species—will not only be less costly to maintain over time but also will be better able to tolerate the unpredictable weather patterns that loom in the future.[22] In this regard, American designers have much to learn from their European counterparts, who have a long tradition of using cosmopolitan plant associations to create naturalistic landscapes.[23]

My third and final suggestion is to recognize, at some point during the design process, the ongoing need for maintenance on all constructed landscapes. All too often the concept of sustainability is misinterpreted to mean self-sustaining, a fantasy that is as false in horticulture as it is in ecology. Landscape maintenance is necessary in order to promote the successful establishment of new plantings, as well as to counteract the effects of disturbance—both natural and human—which continually threaten the integrity of mature plantings. From the horticultural perspective, a truly sustainable landscape design is one that is in balance with the financial resources available to maintain it.[24]

My recommendations for creating sustainable landscapes are really little more than a plea for the practice of sound horticulture. It's not a glamorous message, but to ignore it means that beautiful designs will fall apart and romantic restorations disappear. By grounding their work in horticulture, landscape professionals of every stripe can make a small, but significant, contribution to cleaning up the mess that people have made of the planet.

NOTES

[1.] A substantially different version of this article was published under the title "Neocreationism and the Illusion of Ecological Restoration," in *Harvard Design Magazine* 20 (2004): 87–89.

[2.] David Pimentel, Lori Lach, Rudolfo Zuniga, and Doug Morrison, "Environmental and Economic Costs of Nonindiginous Species in the United States," *BioScience* 50 (2000): 53–65.

[3.] William J. Clinton, "Invasive Species," Executive Order 13112, February 3, 1999, *Weekly Compilation of Presidential Documents* 35 (5) (February 8, 1999): 157–210.

[4.] National Invasive Species Council Management Plan, "Meeting the Invasive Species Challenge." January 18, 2001 (http://www.invasivespecies.gov/council/nmp.shtml).

[5.] In 2003, the Limahuli Garden of the National Tropical Botanical Garden on the island of Kaua'I in Hawaii was spending approximately $30,000 per acre on removing invasive species and replanting native vegetation. How successful this treatment will be over time remains to be seen.

[6.] Peter Del Tredici, "Nature Abhors a Garden," *Pacific Horticulture* 62, no. 3 (2001): 5–6.

[7.] Daniel Janzen, "Gardenification of Wildland Nature and the Human Footprint," *Science,* 279 (1998): 1312–13; Mark A. Davis and Lawrence B. Slobodkin, "The Science and Values of Restoration Ecology," *Restoration Ecology* 12 (2004): 1–3.

[8.] Michael G. Barbour, "Ecological Fragmentation in the Fifties," in *Uncommon Ground,* ed. William Cronin (New York: W. W. Norton, 1995), 233–55.

[9.] Jean Fisk and William A. Niering, "Four Decades of Old Field Vegetation Development and the Role of *Celastrus orbiculatus* in the Northeastern United States." *Journal of Vegetation Science* 10 (1999): 483–92.

[10.] Peter Vitousek, "Beyond Global Warming: Ecology and Global Change," *Ecology* 75 (1994): 1861–76.

[11.] David R. Foster and John D. Aber, *Forests in Time: the Environmental Consequences of 1,000 Years of Change in New England* (New Haven, Conn.: Yale University Press, 2004).

[12.] Charles H. W. Foster, ed., *Stepping Back to Look Forward: A History of the Massachusetts Forest* (Petersham, Mass.: Harvard Forest, 1998).

[13.] Shepard Krech III, *The Ecological Indian: Myth and History* (New York: W.W. Norton, 1999).

[14.] David Foster, Glen Motzkin, D. Bernardos and J. Cardoza, "Wildlife Dynamics in the Changing New England Landscape," *Journal of Biogeography* 29 (2002): 1337–1357.

James P. Sterba, "Landscape Architects: Deer Are Designing Future Look of Forests." *Wall Street Journal,* December 1, 2004.

[15.] Jillian W. Gregg, Clive G. Jones and Todd E. Dawson, "Urbanization effects on tree growth in the vicinity of New York City." *Nature* 424 (2003): 183–87.

[16.] Sarah H. Reichard and Peter S. White, "Horticulture as a pathway of invasive plant introductions in the United States." *BioScience* 51 (2001): 103–13.

[17.] Andrew P. De Wet, Jonathan Richardson and Catherine Olympia, "Interactions of land-use history and current ecology in a recovering 'urban wildland.'" *Urban Ecosystems* 2 (1998): 237–62.

[18.] Arthur F. M. Meuleman, Hans Ph. Beekman, and Jos T. A. Verhoeven, "Nutrient retention and nutrient-use efficiency in *Phragmites australis* stands after wastewater application." *Wetlands* 22 (2002): 712–21.

[19.] Paul D. Thacker, "California Butterflies: at Home with Aliens," *BioScience* 54 (2004): 182–87. Carla D'Antonio and Laura A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis," *Restoration Ecology* 10 (2002): 703–13.

[20.] Dennis Normile, "Expanding trade with China creates ecological backlash." *Science* 306 (2004): 968–69.

[21.] Philip J. Craul, *Urban Soils: Applications and Practices* (New York: John Wiley and Sons, 1999).

[22.] Peter Del Tredici, "Survival of the most adaptable." *Arnoldia* 60, no. 4 (2001): 10–18.

[23.] Nigel Dunnett and James Hitchmough, eds., *The Dynamic Landscape* (London: Spon Press, 2004).

[24.] Hein Koningen, "Creative management," in *The Dynamic Landscape,* Nigel Dunnett and James Hitchmough, eds., (London: Spon Press, 2004), pp. 256-292.