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The ARNOLD ARBORETUM of HARVARD UNIVERSITY

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Inside front cover: Senior botanical assistant Bonakele Mpecheni (left) and curator Martin Smit (right) from the Stellenbosch University Botanical Garden observe a king protea (*Protea cynaroides*), the national flower of South Africa. Photo by Miles S. Sax.

Inside back cover: The last few leaves on a Chinese tupelo (*Nyssa sinensis*, accession 374-81-B) glow scarlet and orange on a gray November day. Photo by Nancy Rose.

Back cover: A Norfolk Island tree fern (*Cyathea brownii*) reaches skyward in the fern house at the Stellenbosch University Botanical Garden. Photo by Miles S. Sax.

Seeing the Landscape in Landscape Art

Edward K. Faison

In 1825, a young British immigrant, captivated by the wild scenery of the Hudson River and nearby Catskill mountains, endeavored to promote America's natural wonders as a distinctive national identity. That year Thomas Cole began painting the undeveloped landscapes of the Northeast with romantic grandeur and literal exactitude, inspiring a cadre of followers that produced America's first painting movement. The Hudson River School (HRS), as the movement was later named, thrived for the next half century before being replaced by the misty, ethereal landscapes of the tonalists made famous by George Inness in the 1880s and 1890s. In an ironic twist, a painting fraternity (the HRS) founded to celebrate America's wilderness became synchronous with a brief period in the northeastern United States in which the landscape was altered to a greater extent than at any time since the last ice age. Because photography was in its infancy during this period and because intensive observation and faithful depiction of nature as well as the study of natural science were integral to the HRS's ethos, nineteenth century American landscape painting affords a window into the dramatic ecologi-

COURTESY OF THE METROPOLITAN MUSEUM OF ART

Thomas Cole's 1836 painting, *View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm—The Oxbow.* Cole included a portrait of himself working at his easel, dwarfed by the surrounding forest, in the lower center of the painting.

COURTESY OF THE NATIONAL GALLERY OF ART, WASHINGTON, D.C

Deforestation is evident in George Inness's *The Lackawanna Valley,* circa 1856.

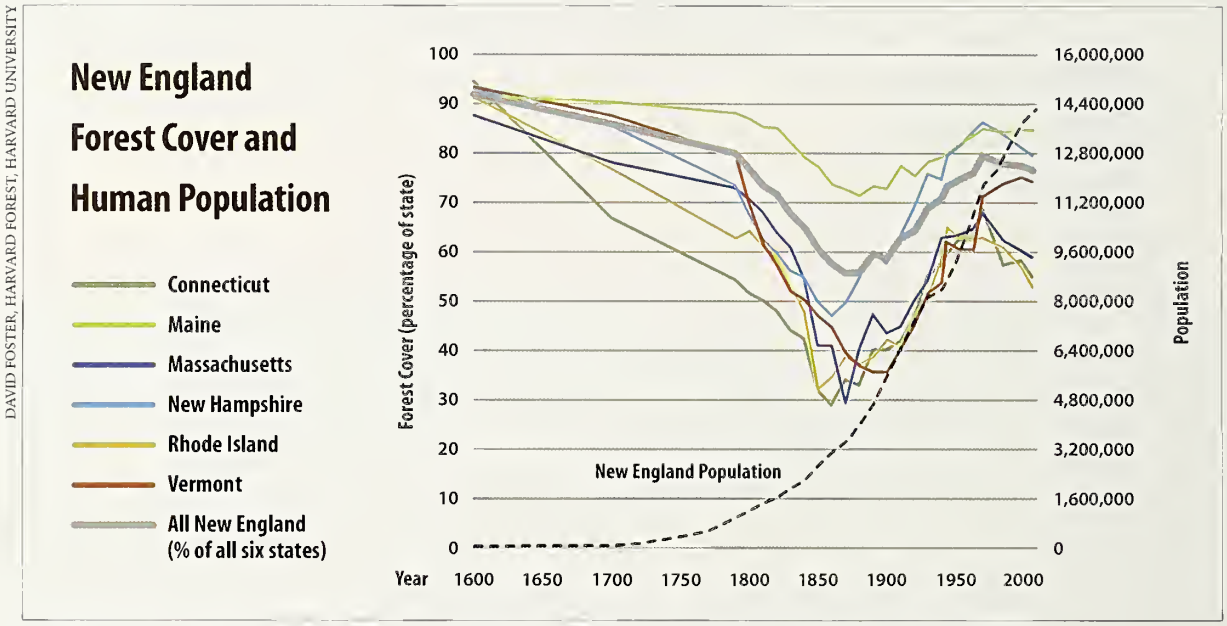
cal changes that occurred across the region. In turn, these spectacularly rendered landscapes, when viewed with an eye toward ecology and natural history, can be seen afresh.

From Forests to Fields

Few paintings capture the overarching landscape dynamic of nineteenth century northeastern North America as effectively as Cole's *View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm—The Oxbow.* Painted in 1836, *The Oxbow* depicts a wild, storm-battered forest clinging to the slopes of Mount Holyoke under a darkened sky, juxtaposed against a sunlit, cultivated landscape surrounding the Connecticut River's oxbow below. Cole seems to capture the moment just before humanity on the right sweeps across the canvas and conquers the remaining wild nature on the left. Cole was certainly aware of and somewhat ambivalent toward the dramatic changes to the land that were occurring around him. Although he admired the cultural achievements of Europe and anticipated similar cultural greatness in America, he also decried the rapid loss of forest that inevitably accompanied the advancement of civilization. In 1841, Cole wrote on behalf of the forest:

> Our doom is near ... These slumbering mountains, resting in our arms, Shall naked glare beneath the scorching sun, And all their wimpling rivulets be dry. No more the deer shall haunt these bosky glens, Nor the pert squirrel chatter near his store. A few short years! —our ancient race shall be, Like Israel's, scattered 'mong the tribes of men.

Cole wasn't far from the truth. In fact he was witnessing one of the greatest acts of deforestation the world has ever known. While forest clearance took several centuries in Europe, in eastern North America it was largely condensed into two generations. From about 1810



DAVID FOSTER, HARVARD FOREST, HARVARD UNIVERSITY

This figure shows changes in forest cover in the New England states compared to human population.

to 1870, much of the forested northeastern United States was transformed into a mosaic of agricultural fields and cut-over woodlots. By mid-century every New England state except for Maine was less than 50% forested. Southern New England and Vermont, at their nadir, were only 30 to 35% forested (see figure above), and by the 1880s New York state was reported to be less than 25% forested.

George Inness reveals this dramatic toll on the northeastern forest in *The Lackawanna Valley* (circa1856). This prominent early work by Inness depicts the stump-strewn landscape around the incipient Scranton, Pennsylvania, bisected by a churning locomotive, all witnessed by a central, reclining bystander. It is both a jarring scene of the raw conversion of forest to field and a powerful statement that humanity is no longer dwarfed in the presence of wild nature (as Cole portrayed himself in *The Oxbow*) but rather dominion over it.

A decade after Inness's *The Lackawanna Valley*, Jasper Cropsey painted a nearby northeastern Pennsylvania landscape. *The Valley of Wyoming* (1865) depicts a sweeping landscape so open, with fields ascending high on the slopes of the distant hills, it suggests a savanna landscape of the American west or east Africa, with scattered trees and expansive grassland rather than the eastern deciduous forest landscape that it is. The stumps are gone, evoking a subdued and bucolic scene in which cows and people lounge peacefully beneath what appears to be a spreading, vase-like elm tree. A myriad of colors emanate from the variety of land uses—hay meadow, cow pasture, various grain fields—of the surrounding fields. Indeed, habitat destruction is often far from our mind when we view agrarian scenes like the *The Valley of Wyoming*. There is good reason for this response. An elevated perch overlooking an open plain with scattered trees and nearby water is the single most appealing landscape to humans, simulating our ancestral savanna home in Africa and closely describing many nineteenth century landscape paintings.

But as *The Lackawanna Valley* poignantly reminds us, semi-open landscapes, though innately appealing, do not occur naturally in the environment of the northeastern United States. They are almost entirely the result of deforestation followed by sustained disturbance by human activity. The moist, temperate climate in this region does not sustain grasslands and savanna; instead it grows forest almost

Jasper Cropsey's *The Valley of Wyoming*, 1865, depicts the agrarian landscape that replaced eastern forests. Courtesy of the Metropolitan Museum of Art.

everywhere except for a few inhospitable and temporarily disturbed locations. As forest ecologist E. Lucy Braun (1950) wrote:

> When the Pilgrims came to this continent, New England was covered by forest interrupted only where lakes or bogs and river swamps made tree growth impossible; where sand deposits near the coast were unsuitable for closed stands; where fire or windfall had temporarily destroyed the forest; where Indians had burned the forest (especially near the coast); and where rock outcrops occurred in the more rugged sections.

One would have to travel back 12,000 to 14,000 years to the end of the last ice age to find an environment that supported open landscapes in the Northeast at a scale comparable to the agrarian landscapes of the nineteenth century. Then, cold climates south of the waning ice sheet sustained a mix of tundra grasses and sedges and scattered spruce trees in an open "spruce parkland." Mastodons, the now extinct cousins of modern day elephants, were common in this transitional landscape between tundra and forest, and these large herbivores probably helped maintain the landscape's semi-open character, much the way elephants do in African savannas today.

Disturbances in the Nineteenth Century Landscape

The tranquility evoked by Cropsey's *Valley of Wyoming* belies the relentless disturbances required to maintain agrarian landscapes of the Northeast in a semi-open state. However, a closer look at the composition reveals some of these disturbances. In the left middle ground, we see farmhands cutting and collecting hay in an upland meadow near a gray barn. The arduous task of cutting hay meadows by hand provided fodder for livestock in winter, and simultaneously prevented trees and shrubs from invading and overtaking the grass. Cattle

Edge of the Forest (1891) by George Inness shows a forest ecosystem altered by human interventions. Courtesy of Yale University Art Gallery.

themselves were anything but passive inhabitants of the landscape. In the hill pasture in the right foreground, a well-worn path, short cropped grass, exposed rocks, an eroding slope, and even the prominent elm tree all point to the intensive grazing and trampling effects of these animals. Somewhat parallel to the megafauna of the Pleistocene Northeast and contemporary East Africa, domestic livestock maintained grassy pastures by trampling and consuming tree and shrub seedlings.

The prominent elm appears to have been an artistic addition by Cropsey (it doesn't appear in his original field sketch), but it was still an ecologically appropriate addition. Elm trees are particularly resistant to soil compaction and intensive grazing and often were among the surviving trees in heavily grazed areas. As pictured in the left foreground, shrubs and young trees were largely relegated to hedgerows along stone walls, fences, or rock outcrops where they were less accessible to livestock. The source of the two distant rising smoke (or steam) trails is unclear; however, burning of fields was a common practice in the nineteenth century Northeast following harvesting of grain and hay. Like cattle grazing, fire prevented woody plants from establishing, including the thorny shrubs that cows often avoided.

Grazing and burning were not limited to open crop fields and meadows but also frequently occurred in nearby woodlands. *Edge of the Forest* (1891) by George Inness suggests the ecological effects of these disturbances. In this work, likely inspired by scenery near his home in Montclair, New Jersey, Inness invites us to peer through an open, parklike grove of trees with a lush herbaceous layer of grasses and tall

forbs ("wildflowers"). Understory shrubs and trees are sparse, and the ground flora is essentially a continuation of the adjacent meadow—a vegetation structure pleasant enough for a late afternoon stroll by the woman in the center of the composition. Inness's "forest" would be described by ecologists today as a savanna or open woodland. His title and composition therefore reveal much about the structure and disturbances of nineteenth century woodlands near settlements. By removing smaller woody plants, burning and grazing often left mature and fire resistant trees (e.g., oaks) to grow larger with reduced competition. Fire and grazing also reduced or removed the leaf litter, releasing herbaceous plants from the suppressive cover of the dead leaves. Selective cutting of trees for fuelwood further increased the openness of these stands, casting more light on the forest floor and promoting a thriving herbaceous layer. The tall wildflowers emerging above the grasses in the foreground create both depth and balance in the composition and are consistent with the effects of cattle preferentially grazing grasses over forbs.

Large Wildlife—Rare Symbols of the Wilderness

In 1856 Henry Thoreau lamented the depauperate large wildlife community in the fields and

ALLEN MEMORIAL ART MUSEUM, OBERLIN COLLEGE. GIFT OF CHARLES F. OLNEY. BRIDGEMAN IMAGES

The white-tailed deer in Thomas Cole's 1825 landscape painting *Lake with Dead Trees* symbolize untamed wilderness.

woodlots of the eastern Massachusetts countryside, a sentiment that could have been applied to most of the region.

> But when I consider that the nobler animals have been exterminated here—the cougar, panther, lynx, wolverine, wolf, bear, moose, deer, the beaver, the turkey, etc., etc.—I cannot but feel as if I lived in a tamed, and, as it were, emasculated country ... Is it not a maimed and imperfect nature that I am conversant with? As if I were to study a tribe of Indians that had lost all its warriors.

NATIONAL MUSEUM OF WILDLIFE ART, JACKSON WY

A remote forest scene is evoked in Worthington Whittredge's *Deer Watering*, circa 1875

Given this condition of the northeastern fauna in the mid-nineteenth century, it is not surprising that large wildlife are rare in HRS paintings. White-tailed deer do figure prominently in several of Thomas Cole's early landscapes, including *Lake with Dead Trees* (1825), one of a trio of paintings that the artist produced from a trip to the Catskills that would launch his career and the HRS. In this work two deer pass by a lake lined with dead trees in front of a majestic, sunlit and snow-capped peak. The impetus for including deer is clear: a symbol of remote and untamed wilderness. The association of deer and wilderness seems incongruent to us today because we are familiar with an animal well adapted to a mix of forest edge, agricultural fields, and suburban backyards. But in the nineteenth century, deer were relegated to remote wooded areas as a result of unregulated subsistence hunting and a thriving market for hides and meat. Reflecting the severely depleted deer population, HRS landscapes portray deer only occasionally and almost invariably in remote wooded scenes (e.g., Worthington Whittredge's *Deer Watering*, circa 1875, in which deer drink under a vaulted, cathedral-like canopy of trees).

To a twenty-first century viewer, *Lake with Dead Trees* also suggests the possible presence of another large mammal, beaver. Dead trees along a lake shore typically result from rising water levels, and beaver dams are frequently the cause of water level changes in lakes and ponds. However, beaver, the largest rodent in North America and an early victim of the fur trade in New York and New England, were likely already gone from the Catskills by the time of Cole's 1825 sketching trip. By 1840, the few remaining beaver in northern New York were said to be so persecuted that they no longer built dams. Sadly but accurately, HRS artists rarely if ever portrayed beaver or beaver sign, despite the large number of paintings of forested streams and ponds, once the animal's prime habitat.

THE HAGGIN MUSEUM, STOCKTON CA

Albert Bierstadt's *Moose* was painted sometime after 1880 from sketches he made along the Maine/Nova Scotia border, an area that was one of the last strongholds in the Northeast for the species.

ALLEN PHILLIPS, WADSWORTH ATHENEUM MUSEUM OF ART

Wolves were disappearing from the Catskills when Jacob Ward painted *Wolf in the Glen* in 1833.

Moose, the largest deer in the world, suffered a fate similar to that of white-tailed deer and were virtually eliminated from the region. Along with unrestricted hunting, habitat loss from deforestation was especially detrimental to this forest-dependent species. Albert Bierstadt, best known for his dramatic western landscapes, produced one of the few paintings of this animal in the Northeast, *Moose* (after 1880), from sketches made along the Maine/Nova Scotia border—the last stronghold in the northeastern United States during the late nineteenth century for moose. The paper birch (*Betula papyrifera*) in the right foreground combined with the red-berried and opposite branching hobblebush (*Viburnum lantanoides*) in the left foreground reveal this to be a cool northeastern forest.

Jacob Ward portrayed another symbol of the wilderness in *Wolf in the Glen* (circa 1833), a lone wolf (looking more like a wolfhound) at the iconic Kaaterskill Falls in the Catskills. By 1840 wolves were probably extirpated from the Catskills and most of New York south of the Adirondacks—the target of systematic extermination to protect livestock and to allay the fears of a public steeped in a tradition of reviling large carnivores. Ward's painting therefore poignantly depicts a once ubiquitous animal that was vanishing from southern New York just as

the HRS's celebration of the American wilderness was getting started. Few other HRS paintings depict wolves or other top predators such as mountain lions, wolverines, and black bears, all of which were hunted with similar fervor and suffered precipitous declines in the mid to late nineteenth century (all except black bears were completely extirpated from the region by the end of the century).

Remnant Old Forests

Despite the widespread transformation of forests to fields, as well as the dramatic alteration of farm woodlands, relatively sizeable tracts of old growth forest still existed in the mid-nineteenth century Northeast (see Greeley virgin forest map 1850, on page 14). Asher Durand demonstrated a strong affinity for painting undisturbed forest compositions and espoused a particularly strong ethos for representing nature truthfully, stating: "never let [the artist] profane [nature's] sacredness from a willful departure from the truth ... For I maintain that all art is unworthy and vicious that is at variance with truth." In *Adirondack Mountains, N.Y.* (circa 1870), Durand reveals an extensive forested plain of seemingly undisturbed wilderness with a weathered hardwood and hemlock standing sentinel-like on a cliff in the right foreground. The closer hardwood has few large-diameter limbs in the crown and a relatively small leaf area to trunk volume, suggesting a very old tree. As depicted in Greeley's forest maps, the Adirondacks in northern New York were, indeed, one of the remnant strongholds of old growth forest in the Northeast in the late nineteenth century.

Durand also takes us into a forest interior in *Forest in the Morning Light* (1855). Bryophytes grow high on the trunks of hardwood trees, and moss covers the forest floor, which is strewn with multiple pieces of large downed

NEW YORK HISTORICAL SOCIETY, LUCE CENTER 1932.10

Asher Durand's *Adirondack Mountains, N.Y.*, circa 1870, depicts a large expanse of undisturbed forest.

COURTESY OF THE NATIONAL GALLERY OF ART, WASHINGTON, D.C.

Asher Durand's *Forest in the Morning Light* (1855) shows traits characteristic of old growth forest.

wood. Trees range in size and age from sapling to large veteran. The tree leaning to the right has a low taper (i.e., little difference in diameter) from the base of the trunk to the base of the crown. All of these attributes suggest old age and are characteristic of old growth forests in the Northeast. Interestingly, the species Durand chose to include in this particular composition—an apparent white oak (*Quercus alba*) leaning to the right in the foreground, an American beech (*Fagus grandifolia*) with smooth gray bark to the right of the white oak, and perhaps an eastern hemlock (*Tsuga canadensis*) or white pine (*Pinus strobus*) in the left foreground—were dominant species of the forests that greeted the first European settlers. Beech was the undisputed king of northern New England, northern New York, and northern Pennsylvania forests, with hemlock the second most important tree. White oak dominated the forests of the southern half of the region.

EDWARD K. FAISON

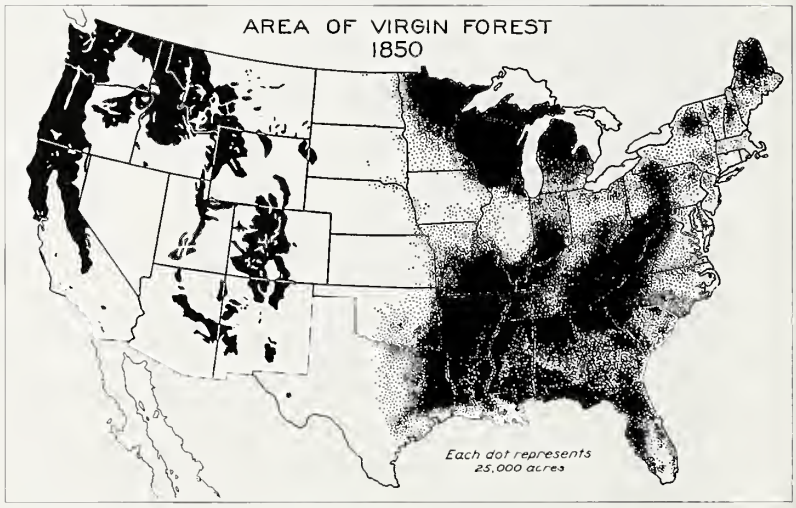
This 2015 photograph from Mount Holyoke showing the Connecticut River oxbow was made from approximately the same location that Thomas Cole painted *The Oxbow* in 1836.

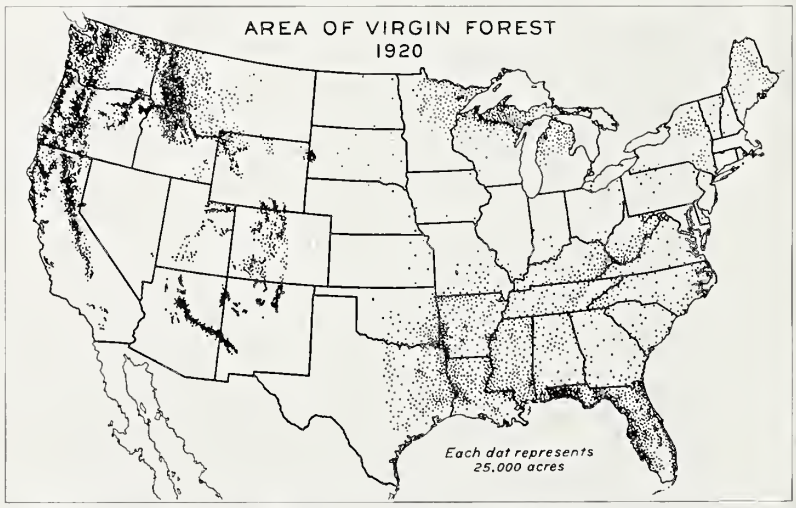
The Great Rewilding

Fast forward 180 years from Cole's iconic *Oxbow* (see photo on previous page). The oxbow, clipped from the main channel in 1840 by flood waters, is now an oxbow lake. But what strikes the ecological eye is that history, rather astonishingly, appears to have moved from left to right since Cole's composition rather than vice-versa. Farm fields still dominate the foreground on the east side of the river, but trees have filled in much of the patchwork of fields on the west side of the river and behind the oxbow. The overall impression of the 2015 landscape is of one *less* heavily influenced by humans than Cole's.

It turns out that Cole was only partly right about the demise of the forest. Trees, especially hardwoods like oaks, chestnut (*Castanea dentata*), and red maple (*Acer rubrum*) are like phoenixes. After being felled, they sprout back rapidly from suppressed buds just below the cut. Other species such as yellow birch (*Betula alleghaniensis*), paper birch, and pin cherry (*Prunus pensylvanica*) germinate and grow rapidly from dormant seeds buried in the soil. Agricultural fields may temporarily suppress forest growth, but tree species with light, windblown seeds such as pines (*Pinus*), maples, and birches rapidly reclaim fields once they are no longer maintained. In the late nineteenth century—just as the Hudson River School began falling out of favor, the Industrial Revolution took hold, and agriculture shifted to the rich midwestern soils—vast areas once cleared for farmland were abandoned and began to revert back to forest. The result was a century-long and inadvertent recovery of the Eastern Deciduous Forest. In 2010, forest covered more of New England than it did in 1836, just as the photograph of the oxbow when compared to Cole's *Oxbow* suggests.

When not overexploited by humans, ecosystems are fundamentally "bottom up", meaning that resources such as light, soil nutrients, and water govern plant production, which grows herbivores, which in turn support predators. With the return of the northeastern forest and a ban on market hunting, deer and eventually moose recovered much of their former range. Beaver were reintroduced to several parts of the region in the early twentieth century and quickly spread, taking advantage of the reforested streams. Black bear began increasing





Rough estimate of "virgin" forest remaining in the United States in 1850 and 1920 (Greely 1925). Virgin forest is better described as "old growth" forest, meaning that it had never been cut by European settlers and had developed old forest characteristics, because many eastern forests were in fact disturbed by Native Americans prior to European settlement.

sharply in the second half of the twentieth century, expanding outward from nineteenth-century refugia and thriving on nuts and acorns in maturing beech and oak forests, as well as on readily available deer fawns. A new wild canid, the coyote, migrated into the region from the western plains, partially filling the vacated niche left by the extirpated wolf. In its eastward expansion, the coyote interbred with wolves in the eastern Canadian provinces, producing a larger version of its western progenitor and an animal capable of bringing down deer. More recently, the vanguards of extirpated large carnivores have begun passing through the Northeast. At least four wild gray wolves and four wild cougars have been confirmed in the region in the past two decades, and unconfirmed sightings of cougars have increased dramatically.

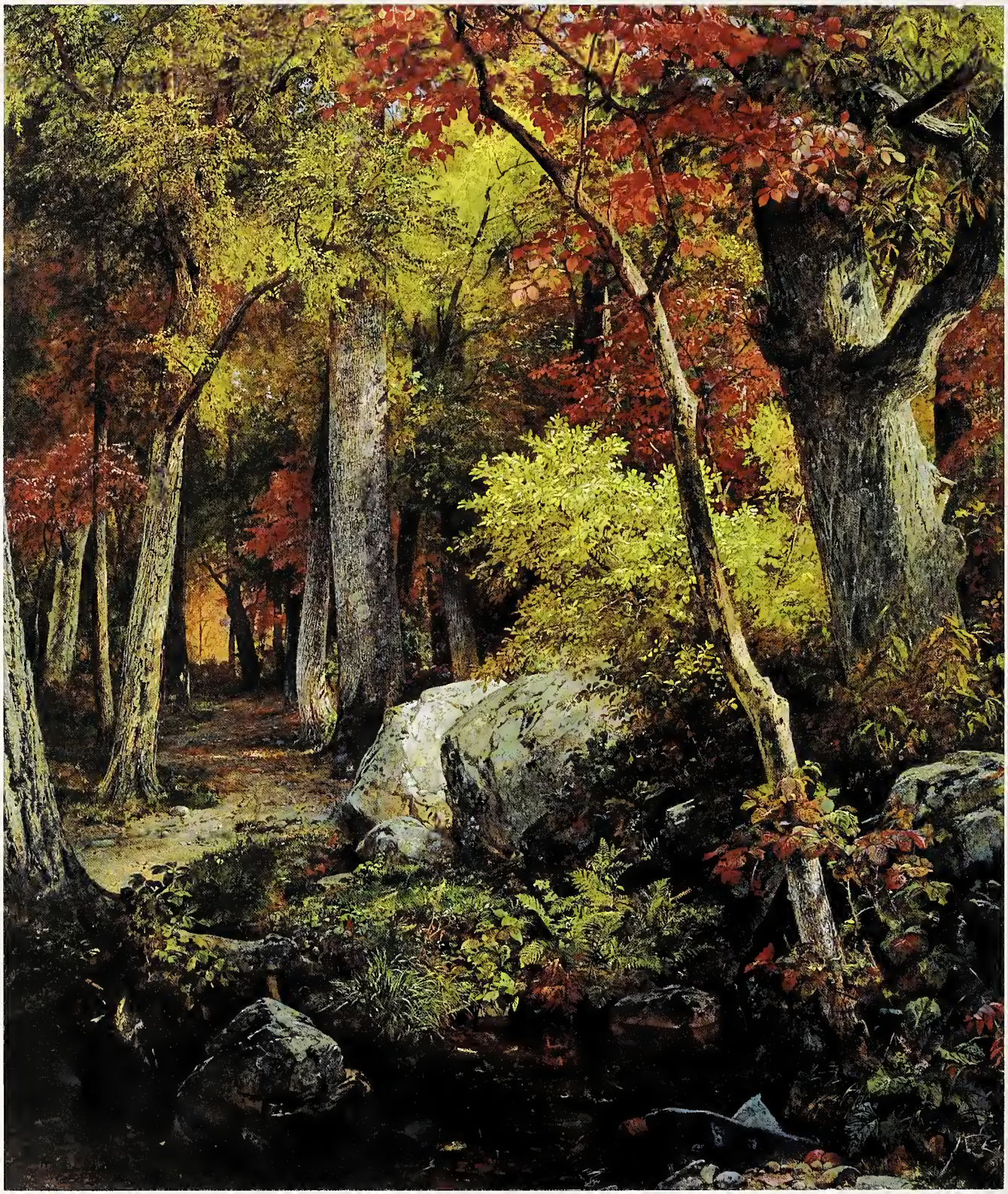
Of course, not everything has returned to a wilder condition today compared with 1836. Gone is an avian wonder that Cole may have seen from Mt Holyoke's summit: the passenger pigeon. This species once congregated in flocks in the millions, even billions, before being robbed of its forested habitat and hunted to extinction by the end of the nineteenth century. Wolverines still occurred in the Adirondacks as of 1842 and were reported to be in Pennsylvania, Maine, Vermont, and even in the Hoosac range of Massachusetts in the nineteenth century. These largest members of the weasel family remain far north of the United States today in upper Quebec and Newfoundland. Elk still roamed parts of New York and caribou inhabited northern Maine in the mid-nineteenth century, but both animals remain extirpated from those states today.

There are also far fewer old growth forests today than in 1836, even if the percentage of forest area today is higher. Forest greater than 200 years in age cover only about 0.4% of the northeastern United States, compared with the relatively sizeable tracts of old growth forest in the mid-nineteenth century (see 1850 Greeley map, on facing page). The long-lived beech, white oak, and hemlock that dominated early colonial forest composition, have been replaced by shorter-lived and earlier successional species such as red maple, black cherry (*Prunus serotina*), and birches in the younger forests that have grown back on abandoned farmland and cutover lands. The large pieces of downed wood and moss covered trees in Durand's *Forest in the Morning Light* are far less common in today's drier, second growth forests. Forest wildflowers are generally less abundant and diverse in second growth forests compared with old growth forests, and bird densities are also lower in the former compared to the latter.

Novel Threats

One of the factors that has slowed the recovery of beech and hemlock to their former positions of dominance in northeastern forests is the invasion of forest pests and pathogens from Eurasia. The exotic fungus *Nectria coccinea* var. *faginata*, introduced to Nova Scotia in the early 1900s, has subsequently spread throughout the Northeast, invading the bark and killing many mature beech trees. Hemlock woolly adelgid, an aphidlike insect introduced from Japan, reached New England in 1985 and has thinned the canopy and killed many hemlocks in the southern parts of the Northeast. But by far the most dramatic change to the modern forest resulting from an introduced forest pest is a tree portrayed in William Trost Richards's *October* (1863).

Richards was a member of a brief movement in the 1850s and 1860s that called themselves the Association for the Advancement of Truth in Art. Inspired by the British art critic John Ruskin, the American Pre-Raphaelites (as the group was later named) took the accurate portrayal of nature to a new level. In *October*, Richards's highly detailed rendering of an autumn forest scene enables us to identify the large tree on the right of the composition with diamond-shaped furrows on the trunk and linear sawtooth leaves with considerable confidence: an American chestnut (*Castanea dentata*). A chestnut this size hasn't been seen in the forests of the Northeast in perhaps 75 years. Forty years after Richards's painting, the Asian chestnut blight (*Cryphonectria parasitica*) arrived in New York City, and over the next several decades destroyed virtually every mature chestnut throughout its Appalachian



Because of the introduction of chestnut blight, northeastern forests no longer contain large specimens of American chestnut like the one seen on the right side in William Trost Richards's *October* (1863).

mountain range. Chestnuts today rarely grow above 15 centimeters (6 inches) in diameter, perhaps 1/5 to 1/6 the diameter of the tree in Richards's painting, before being killed by the blight and therefore almost never emerge into the forest canopy. Interestingly, the smaller tree to the left of the chestnut in the right foreground, flowering dogwood (*Benthamidia florida*; syn. *Cornus florida*), has also been struck by an exotic fungus, dogwood anthracnose (*Discula destructiva*), and has declined significantly in recent decades.

The Future Landscape: Stemming a Second Deforestation

Looking north from the summit of Mount Holyoke, past the farm fields that have succeeded to forest, an unmistakable threat to the forested landscape can be seen: the patchwork of residential and industrial development and roads fragmenting and perforating the forests and farm fields. As the forest grew back in the twentieth century after farm abandonment, human populations also surged. By 1975, the human juggernaut caught up to the regenerating forests, and the pendulum of 100 years of forest recovery began to swing back towards forest loss (see forest and population map). Forty years later, forest loss is in near free fall in New Hampshire and the southern New England states. More recently, Vermont began losing forest at an increasing rate. Only Maine has been able to sustain a balance between forest loss and forest recovery, although residential development is projected to increase significantly in the southern part of the state over the next two decades. This deforestation is much harder for trees to recover from than before. Paved roads and housing developments represent a "hard deforestation," in contrast to the "soft" deforestation of agricultural fields in the nineteenth century (Foster et al. 2010).

How will the northeastern landscape look in the next 50 to 100 years? The answer depends in large part on whether conservation groups, private landowners, public agencies, and other stakeholders are willing to work together to protect both forest and farmland. The news so far is promising. In the past 10 to 15 years, partnerships of conservation groups that transcend political boundaries have increased by a factor of six in New England and adjacent New York. This type of regional collaboration is at the heart of *The Wildlands and Woodlands Vision* created by 20 scientists and environmentalists across the region. The Vision calls for the permanent protection of 70% (30 million acres) of the New England region in forest over the next 50 years. Like the structure of an ecosystem, the *Wildlands and Woodlands Vision* is fundamentally a bottom up (grass roots) effort. It has to be: over 80% of New England's forestland is privately owned.

If he were alive today, Thomas Cole would be amazed to see more forest cover in New England than he saw in 1836. But he would once again recognize and lament the signs of deforestation. History has inadvertently given us a second chance to live in a forested New England, but there will be nothing inadvertent about the efforts needed to keep these forests standing.

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Edward K. Faison is Ecologist at Highstead in Redding, Connecticut.

The Etymology of Parking

Michele Richmond

park (circa 1845)
verb
a. to plant a tree or spread a patch of turf or flowers
b. to create a little patch of parkland

park (circa 2015)
verb
a. (1) to bring a vehicle to a stop and keep standing at the edge of a public way
(2) to leave temporarily on a public way or in a parking lot or garage
b. to enclose in a park

I've always wondered why we use the word parking to describe a place to leave a car. For me the word evokes images of my neighborhood park, playgrounds, or New York's Central Park: lush green spaces, not places easily reconciled with a patch of asphalt. A few years ago while I was working at the New York City Department of Parks and Recreation, I finally got my answer.

While exploring the history of street trees, I came upon a law passed by the United States Congress on April 6, 1870, authorizing the city

SHAWN STANKEWICH

Public green spaces like New York City's Central Park, seen here, add to the livability of urban areas.

DUMBARTON OAKS

Pierre Charles L'Enfant created the original design for the layout of streets in the city that became Washington, D.C.

of Washington, D.C., to set aside up to 50 percent of the width of a street for the creation of "parks for trees and walks." At that time, the Senate debated about the proper layout of the street, whether to have "the parking on either side of the street and the roadway in the center" or to have the "parking" in the center of the street. According to the 41st Congress, the proper way to park in cities was on the side of the streets with the roadway running down the center. Of course, in 1870 the members of the Senate were discussing the parking of trees and smaller plants, not automobiles. The first parking system was an early street tree system where parking defined the planting of trees, grasses, and flowers along the side of roadways and the creation of sidewalks for pedestrians.

Parking: From Trees to Cars

Pierre Charles L'Enfant, a French-born American architect and civil engineer, was tasked by President George Washington to design the layout of streets for the new "Federal City" (later named Washington City, District of Columbia). The L'Enfant plan of 1791 set up a gridded system of streets and diagonal avenues that were exceptionally wide—160 feet for avenues and 80 feet for streets—to live up to his grandiose vision of the new capital city. Having grown up in Paris, L'Enfant's proposal for the improvement of the roadways was influenced by the boulevards of Paris. As a result of this upbringing, he suggested that a double allée of trees be planted on each side of the avenues. While L'Enfant had intended for his streets to be lined with trees, a very small number of avenues were actually planted under his supervision. Decades later, it was the passing of the 1870 law that provided the impetus to line all streets with parking.

Following the passing of the 1870 law, the Parking Commission of Washington, D.C. (founded in 1871) immediately embarked on a massive campaign to create parking on all roads within the city. More than 70,000 trees were planted on the streets of Washington in the first decade of the campaign under the expert supervision of Truman Lanham (the first Superintendent of the Parking Commission), William R. Smith (Superintendent of the United States Botanical Garden), William Saunders (Superintendent of the Grounds of the Department of Agriculture), and John Saul (owner of a local tree nursery).

From 1872 until 1915, the trees for the streets were grown in a nursery on the grounds of the Washington Asylum. This allowed the Parking Commission to control the quality and diversity of trees that were planted in parking places, which resulted in a 95 percent tree survival rate 12 years after the initial plantings. A 95 percent survival rate is impressive by today's standards. Street trees today in New York City have a 73.8 percent survival rate 9 years after planting, despite enhanced maintenance and monitoring through the MillionTreesNYC program. In smaller cities today, street trees fare even worse. Through the Sacramento Shade Tree program, only 68.9 percent of street trees survived in the 5 years after planting.

The extraordinarily high survival rate for street trees in Washington, D.C., in the late 1800s led to a plethora of mature trees and an overall greening of the city. By the mid-1880s, after almost two decades of tree growth, *The Century Magazine* reported that "in this matter of trees, Washington is unrivaled among all the cities of the world." During the first plantings of the parking trees, citizens would

place wooden boxes around the trees to protect them, but with the passage of another congressional law placing the jurisdiction of parking places squarely in the hands of the Commissioners of Washington, D.C., this practice was soon discarded. The new law had unintended consequences: the removal of the protective boxes allowed people to wedge their way into the parking system. How? Because during the hot summers in Washington, trees provided shade for horses while their owners were off in a shop or visiting a friend. Owners would tie their horses (and carriages) up to the street trees, effectively decreasing a two-lane road to one active lane and one stopped lane. Although it became illegal in 1882 to trespass on parking, or to cut, injure, or maim parking trees in any way, the convenience and shade provided by the trees for the waiting carriages and horses outweighed the fine levied.

COURTESY OF HATHITRUST

An illustration from the article "The New Washington" (*The Century Magazine*, March 1884) shows a protective structure around the trunk of a street tree on Thomas Circle in Washington, D.C.

Automobiles Arrive

The world was changing rapidly as the twentieth century arrived. The number of automobiles in the United States increased from 8,000 in 1900 to over 8 million in 1920 and marked a major shift in the meaning of the term parking. Just as people would tie their horses to the parking trees, automobiles began to stop next to the parking strips lining each road. The increase in the number of automobiles on the road, the enhancements made to the National Mall, and the See America First tourist campaign, which began in 1910, led to a huge increase in the number of cars in Washington, D.C., from both locals and tourists.

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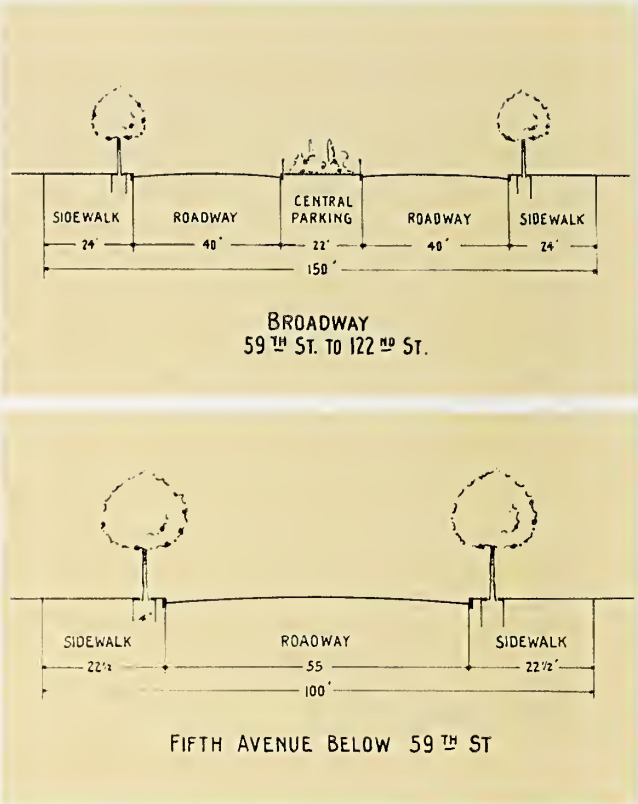
This image from a 1915 *National Geographic* article about Washington, D.C., shows both an early automobile and a horse-drawn carriage taking advantage of shade from street trees.

The See America First campaign was designed and implemented by America's railroad companies and advertised America's first National Parks. Advertising for the National Parks, the majority of which were located in the western United States in the early 1900s, benefited the railroads immensely: more tourists journeying out west meant more money. However, the railroads did not foresee the rapid growth of the automobile and an unintended consequence of the See America First campaign was regional tourism (as opposed to national tourism). With all the positive press Washington, D.C., received from the greening of their streets through parking, the city received more tourists than any other city in America in the 1920s and 1930s.

Of course, the Washington, D.C., Parking Commission had not planned for the automobile when setting out their parking system. By the mid-1920s city officials began cutting down street trees and widening streets to accommodate the volume of cars, thereby replacing the original meaning of parking as a place for trees and greenery with parking as a place for automobiles to stop. Some of the earliest instances of this shift appear in *Washington Post* articles from the 1920s, where the term "parking" was used to explain where cars were parked rather than to where trees were planted.

This 1924 photograph, captioned "With Washington melting under the hottest day of the year, Russell T. Edwards of the American Tree Association starts a new style for men by throwing his hat away and carrying a Chinese parasol," shows no trees along the street in the foreground or the background and cars lining the street, emphasizing the quick transition from the original parking to the new parking.



Laurie Davidson Cox's 1916 publication *A Street Tree System for New York City, Borough of Manhattan* includes designs that show tree and plant parking as well as streets that are wide enough to accommodate car parking.

Washington, D.C., was the first city to implement a parking system in the United States, but the concept of parking was picked up and modified by New York City in 1916 with the publication of landscape architect Laurie Davidson Cox's *A Street Tree System for New York City, Borough of Manhattan*. Cox's street sections give weight to both tree parking and car parking, exemplifying the early twentieth century shift in the meaning of the term "parking." For example, his section through Broadway from 59th Street to 122nd Street shows plant parking in the center of the street and tree parking along the sidewalk, with enough space on each side of the street for car parking. Again, his section of 5th Avenue below 59th Street shows a 55-foot wide street with space for car or carriage parking on either side of the street (see top right).

The public expects amenities on the street such as shade provided by trees, places to leave their carriages (or cars), and safe places to walk. These expectations shifted significantly in the first few decades of the twentieth century as needs changed. Throughout the remainder of the twentieth century, these needs evolved and the relationships in the streets between trees, people, transit, businesses, and vehicles continued to shift. The arrival of the car as the main mode of transportation necessitated a shift in the amenities of the public right of way, favoring car parking over tree parking in the 1910s and 1920s. The results of this early twentieth century shift is still prevalent on our streets today, with car parking occupying a large portion of the street.

Bringing Back Tree Parking

However, car parking may not always have a place of utility along roadways. In today's streets, a shift away from car parking towards other modes of transportation and use of the streets is occurring. For San Francisco's 6th Street Improvement Project, the city conducted direct interviews with local low-income resi-

MICHELE RICHMOND

Extensive plantings and wide sidewalks make city streets more usable and inviting.

dents to determine what they wanted on their street. Since car parking spaces are useless to many low-income San Franciscans, the neighborhood ranked street amenities (from highest priority to lowest priority) as: walking, street trees, public transit, biking, and car parking. These rankings have guided the redesign of the street away from parking towards a multimodal street with a significant increase in the number of planned street trees.

In another shift, Seattle has prioritized the creation of Green Streets throughout the city. Seattle Department of Transportation's U District Green Streets Concept Plan emphasizes the planting of healthy, consistently placed street trees, calling street trees crucial to the character and livability of the city. Their plan prioritizes street trees, perennial and shrub plantings, bike parking, and pedestrian movement over car parking along the Green Streets.

The City of Toronto has set a goal of increasing their overall tree canopy of 10.2 million trees by approximately 13 percent over the next few decades. The city recognizes the wide range of environmental, ecological, social, cultural, and economic benefits their urban forest provides for residents and has developed multiple strategies to increase their overall tree canopy. At the street level, the city has worked diligently to increase street tree planting and survival rate in conjunction with better public transit and ease of walking. One strategy they have implemented is the use of below pavement soil structural systems (such as Silva Cells) that allow soil to receive air and water without being compacted by people, bikes, and buses moving above them. The strategy has been so successful that Silva Cells are now being deployed across the city to allow large shade trees to grow successfully in congested urban conditions.

The story of parking over the past 140 years exemplifies changing social norms, ways in which city planners absorb technological advancements such as the birth of the automo-

bile, and the renewed appreciation of the importance of the natural landscape to the well-being and quality of life of city residents. As we shift rapidly towards better public transit infrastructure, complete streets, and walkable cities, it is time to rethink what the "parking" amenity is. Cities like San Francisco, Seattle, and Toronto have realized the importance of natural landscapes and the benefits that the urban canopy brings to cities, and no doubt other cities will start or continue efforts to reorient streets toward green infrastructure, public transit, and people. Instead of parking meaning either the parking of trees or the parking of cars, perhaps this new shift will reinvent parking and assume a definition that incorporates a broader set of ideas that coexist together: the importance of street trees and the urban canopy, the expansion of green and public transit, the walkability of streets, new modes of transportation, and the livability of cities.

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Seattle's "Swale on Yale" offers attractive planting beds that also serve to filter runoff.

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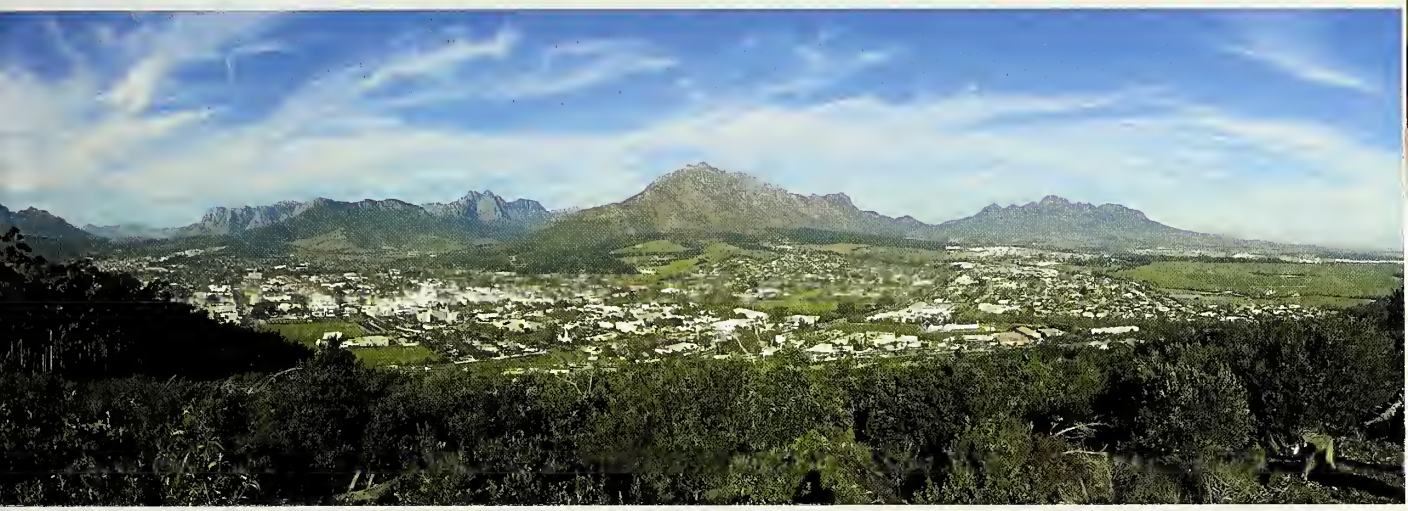
Michele Richmond is a Site Designer at Swift Company Landscape Architecture in Seattle, Washington. Her love of urban trees grew out of a summer spent researching street trees for the New York City Parks and Recreation Department.

The Bonsai Collection of Stellenbosch University Botanical Garden

Miles S. Sax and Willem Pretorius



A panoramic view of Stellenbosch, Western Cape, South Africa. FMALAN AT EN WIKIPEDIA

South Africa has long been recognized for its picturesque landscapes, large wildlife species, and stunning plant diversity. Housing roughly 10 percent of the world's vascular plant biodiversity (about 30,000 taxa) on less than 1 percent of the earth land surface, it is the only country in the world that contains its own floristic kingdom (the Cape Floral Kingdom) within the confines of its borders. With plant endemism rates as high as 70 percent in the Western Cape, South Africa has continued to fascinate plant explorers, botanists, and horticulturists. Flowering geraniums (*Pelargonium* spp.), bird-of-paradise (*Strelitzia reginae*), and the calla lily (*Zantedeschia aethiopica*) are just a few of the South African plants that are now known to gardeners worldwide.

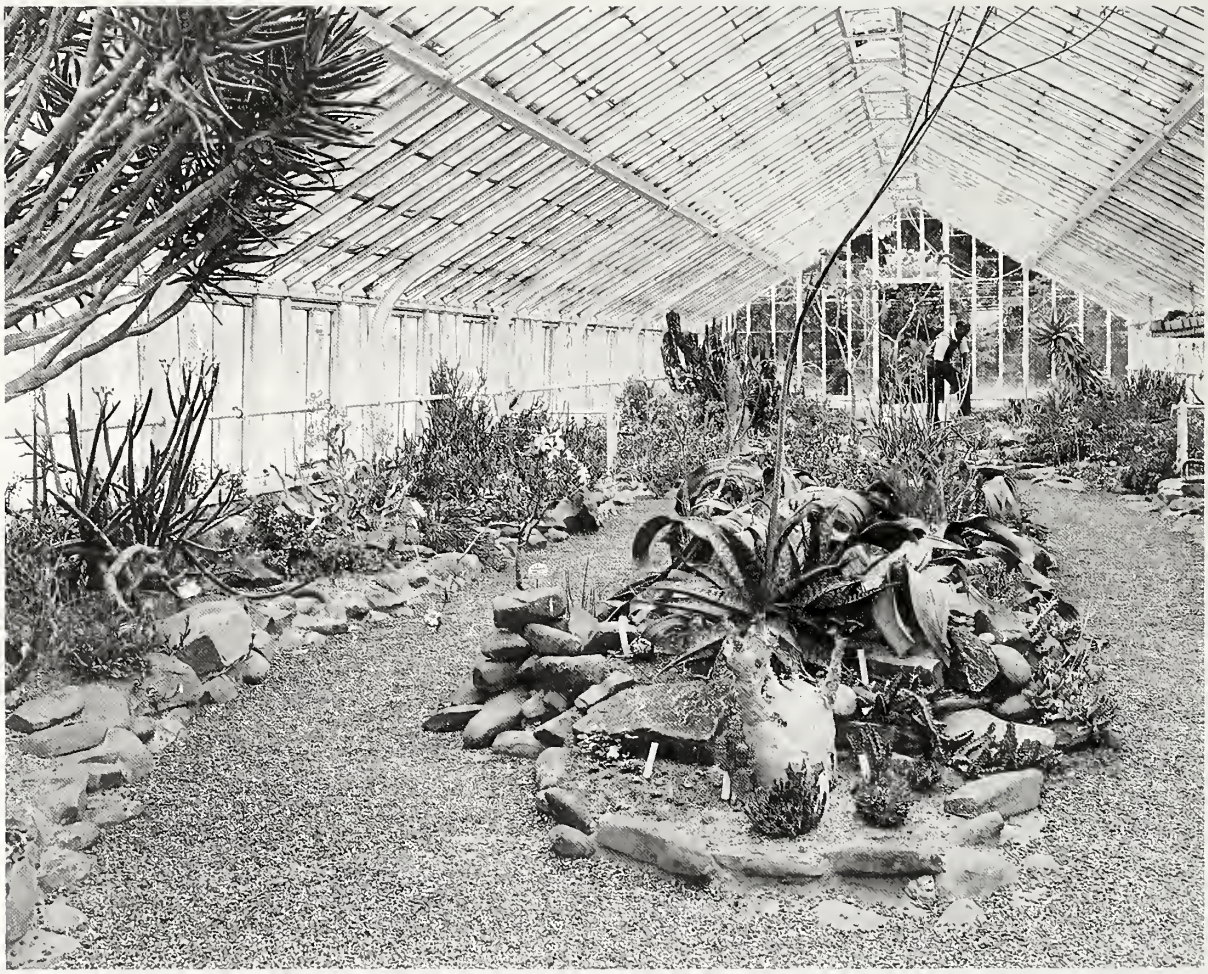
A Garden Grows in Stellenbosch

The town of Stellenbosch is located in South Africa's Western Cape province. It lies on the eastern flank of the Cape Flats, situated at the base of the commanding Hottentots-Holland Mountains, which provide an inspiring backdrop to the municipality. The Stellenbosch University (originally called the Stellenbosch Gymnasium) was established in this agricultural and wine-producing region in 1866. In 1902, the University made efforts to establish the first botanical garden in Africa to be housed in an institute of higher education. Augusta Vera Duthie was the first lecturer in botany at Stellenbosch and undertook this initiative in order to grow plant material for educating botany students at the school. In 1902, the first garden was laid out in front of the Main Building where it remained for twenty years. In 1922, under the guidance of Dr. Gert Cornelius Nel, the garden was moved to accommodate the growing collections and to establish a permanent site. The 1922 design included transectional and circular order beds for botanical education and were inspired by the world's oldest botanical garden in Padua, Italy. As Stellenbosch University Botanical Garden (SUBG) has developed over the decades its plantings and design have changed in response to the evolving mission of the garden and the priorities set

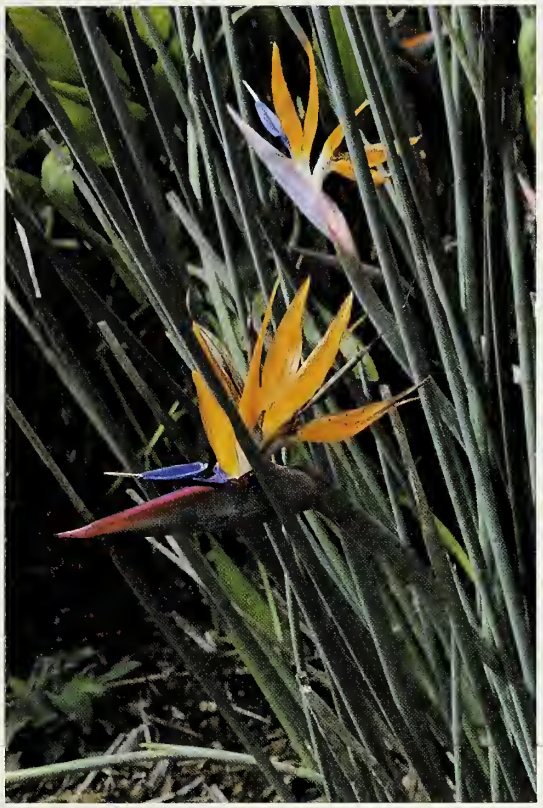
forth by the curators. The garden today features a mix of historical, ornamental, and scientific collections.

Some of the botanical wonders that the garden displays to attract visitors include the Santa Cruz water lily (*Victoria cruziana*), giant Dutchman's pipe (*Aristolochia gigantea*), jade vine (*Strongylodon macrobotrys*), many orchid species, carnivorous plants, a fern house, a tropical greenhouse, and herb and vegetable gardens. It also houses scientific collections such as the South African taxonomic reference collection for the expansive genera *Oxalis* as well as plants of conservation concern that are threatened in the wild such as the king sundew (*Drosera regia*) and the geophyte *Haemanthus pumilio*. The garden also features quintessentially South African collections such as towering groves of giant white bird-of-paradise (*Strelitzia nicolai*), succulent gardens, and a fynbos garden (fynbos is the primary vegetation group of the Cape Floral Kingdom). Its two succulent greenhouses have a storied history based on the extensive collections development undertaken by the SUBG's first curator, Dr. Hans Herre, who accrued vast holdings of succulent flora such as the South African near endemic family *Aizoaceae*. These greenhouses feature some of the garden's most unusual plants such as a quiver tree (*Aloe dichotoma*), the stunningly beautiful *Drosanthemum bicolor*, and the sprawling, contorted gymnosperm, *Welwitschia mirabilis*.

SUBG



This 1966 photo shows one of the Stellenbosch University Botanical Garden greenhouses filled with succulents, *Welwitschia mirabilis*, and other plants.



MILES S. SAX

Clockwise from upper left: Narrow-leafed bird-of-paradise (*Strelitzia juncea*); A formal pond at Stellenbosch University Botanical Garden displays water lilies, including the platter-like Santa Cruz water lily (*Victoria cruziana*); *Drosanthemum bicolor*, a South African succulent with showy flowers.

A Unique Bonsai Collection

One collection in particular at SUBG stands out for its distinctive character—the bonsai collection, whose plants have played a central role in the development of a unique horticulture practice in Africa. Known as the Western Cape Heritage Bonsai Collection, it is the oldest and largest public bonsai garden in Africa. What makes this collection special is the wide variety of indigenous species used, its development by a cast of interesting characters, and the display of the internationally recognized African styles of bonsais.

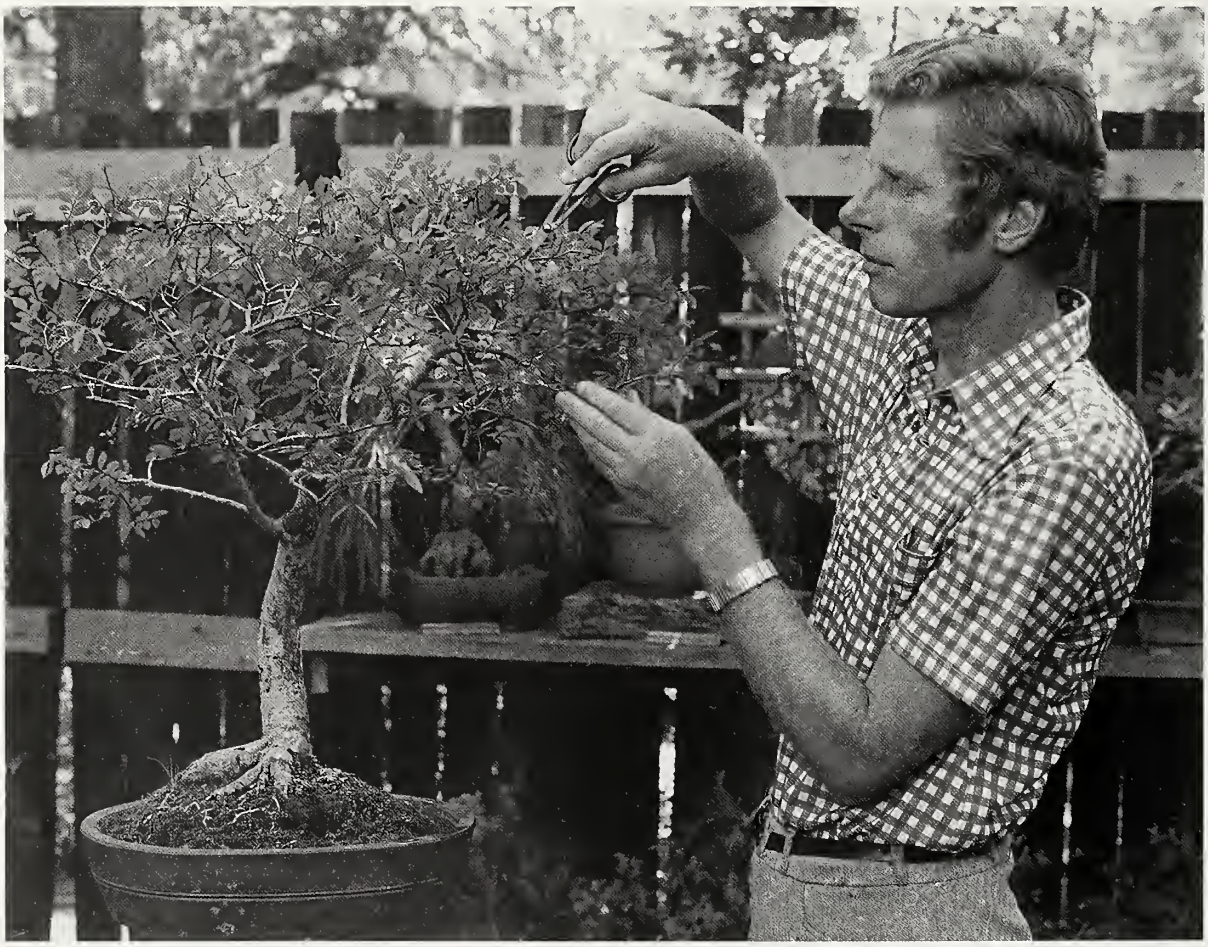
Originally established in 1972, the bonsai collection was incorporated into the gardens by Wim Tijmens, SUBG curator from 1962 to 1999. Wim is recognized for establishing much of the SUBG layout and design that provide the defining elements of the landscape today. His passion for the temperate flora of East Asia took

him on many trips to China and Japan. Many of the stately temperate-climate tree species that are found throughout the garden were acquired during his tenure.

Wim's passion for Asiatic horticulture led him to mastermind the creation and development of the bonsai collection. Much of the success of the garden's bonsai collection and its special focus on African trees can be attributed to his vision. In an article in the Stellenbosch local paper (Tijmens 1968) Wim wrote about a visit to New York and the bonsai in the Brooklyn Botanic Garden: "In South Africa we can give the art of bonsai our own character by using indigenous species. It will create overseas interest and also highlight our own flora." He mentioned that bonsai specimens of some South African trees such as the yellowwood (*Podocarpus falcatus*) were already housed in New York in the collection of Frank Okamura, who maintained the Brooklyn Botanic Garden's bonsai collection from 1947 to 1981.

While there had been some bonsai in the garden since at least 1968, it wasn't until the bonsai collection of Mrs. Becky Lucas was donated in the 1970s that a bonsai-*en* (a structure or space specifically for bonsai) was specially constructed at the SUBG. Lucas is widely acknowledged as the first practitioner of bonsai in South Africa, starting as early as 1939. Over the years, Lucas built up an impressive collection of miniature trees; she was remembered for having over 300 potted specimens on her tiny patio. She made several trips to Japan, spending considerable time studying with Japanese bonsai masters, and was a powerhouse in the promo-

SUBG



Wim Tijmens, Stellenbosch University Botanical Garden curator from 1962 to 1999, is seen working on a bonsai specimen in this undated photograph.

SUBG

Louis Nel with his outstanding *Buddleja saligna* bonsai trained in the Pierneef style.

tion and instruction of bonsai in South Africa. When she donated her collection, SUBG curator Wim Tijmens had some trouble explaining the significance of the gift to the University's chancellor, who didn't know what bonsai was.

The next big donation to the collection came from the Reverend Gerjo van der Merwe, a minister in the Dutch Reformed Church. According to his family, he was one of the first bonsai enthusiasts to grow indigenous bonsai from seeds in South Africa. From Van der Merwe's personal notes his deep love of nature and the belief in the healing power of trees shines through as an obvious motivator for his bonsai passion. Because he was often transferred, he decided to use soil from the family farm in Boplaas in which he transported small trees with him on his travels. "I believe that the growing of bonsai is a healthy help to heal this broken relationship. By growing trees from your own region and to take it with you is a strong way to keep and protect the association with a specific place and the sense of belonging."

The third significant donation of bonsai to the collection was that of Louis Nel. His collection was donated on March 20, 2012. Nel was internationally known as the king of *Buddleja saligna*, an evergreen South African species commonly known as false olive or squarestem butterflybush. Nel started working with bonsai in 1974 and his skill and reputation quickly grew. Throughout his life he was a regular contributor to bonsai magazines and participated in many international bonsai demonstrations. A number of his trees won international competitions; an outstanding example is SUBG accession 2012-1, one of Nel's *Buddleja saligna* bonsai. This tree now stands as one of the garden's premier specimens, highlighting a South African native plant as well as a style of

bonsai training, known as Pierneef, which originated in South Africa and has gained international repute.

In 2010, the garden's bonsai house was moved because the shade of nearby large trees created conditions that were not ideal for bonsai. The bonsai collection is now housed in a large area adjacent to the visitor center and gift shop, giving it a central stage in the garden.

Plant Species in the Bonsai Collection

The SUBG bonsai house contains many familiar bonsai subjects such as conifers and maples. But as one makes one's way through the collection it quickly becomes clear that the plant material is anything but traditional. A wide assortment of tree species from South Africa compose the majority of the collection, interspersing widely variable forms, textures, and unconventional styles. The non-traditional approach to the use of plant material and styles that have developed in South African have set bonsai culture here on its own unique and diverging path from bonsai's origins in China and Japan. The South African ethos of exploration, questioning of status quo, and adaptation is expressed through the developed bonsai culture and exemplifies the meaning of horticulture as an expression of the interaction between the human and plant. The miniature trees that make up the collection are a mix of classical and contemporary styles of bonsai. Many subjects exhibit the traditional strict, regimented, and controlled aesthetic associated with Japanese style, but with the collections use of unusual plant material,

SUBG

A Japanese black pine (*Pinus thunbergii*) bonsai started by South African bonsai pioneer Becky Lucas over 70 years ago.

SUBG

This dormant Natal fig (*Ficus natalensis*) bonsai, recently donated to Stellenbosch University Botanical Garden by Tobie Kleynhans, shows the species' distinctive aerial roots.

An African olive (*Olea europaea* subsp. *africana*, syn. *O. e.* subsp. *cuspidata*) bonsai created by Louis Nel.

it trend towards the less exacting and playful penjing style of China. The tree species found in the SUBG collection weave their own story of the development of bonsai in South Africa.

The oldest trees in the collection date back to the 1940s and were created by South African bonsai pioneer Becky Lucas. Her original trees are the classic bonsai subject, Japanese black pine (*Pinus thunbergii*), which is native to Japan, China, and Korea. As Lucas continued to develop her passion and skill in bonsai, she mostly used the traditional Eastern pallet of plant species including trident maple (*Acer buergerianum*), deodar cedar (*Cedrus deodara*), and Atlas cedar (*Cedrus atlantica*). As the SUBG collection developed over the decades and new bonsai growers added their contributions, many other familiar bonsai subjects joined the collection including dwarf Japanese garden juniper (*Juniperus procumbens* 'Nana'), lacebark or Chinese elm (*Ulmus parvifolia*), and *Ligustrum ovalifoliun*, which oddly goes by the common name California privet despite being native to Japan and South Korea.

Although South African bonsai started out with traditional Eastern influences it has become adapted and transformed as a result of its interpretation in Africa. It is unclear what prompted the beginning of use of African plant species for bonsai in South Africa. It can be speculated that perhaps a lack of suitable imported plant material from Japan and East Asia during World War II might have limited availability.

The first African tree in the collection to be adapted for bonsai was the Natal fig (*Ficus natalensis*) by Ian Ross in 1948. The native range of *Ficus natalensis* extends from Mozambique, Malawi, and Zimbabwe to South Africa. It is cultivated in southeastern Africa as a shade tree and living fence. The genus *Ficus* is commonly used for traditional bonsai and has been a popular choice for growers for many centuries. For example, a specimen of *Ficus retusa* (syn. *F. microcarpa*) in the Crespi Bonsai Museum in Italy is purported to be over 1,000 years old.

Ficus natalensis was likely selected to be trialed in bonsai culture as a substitute for East Asian speeies because it has traits that emulate those of traditional bonsai species. Over the years Natal fig has proved itself as an excellent selection for development as bonsai and its popularity has expanded, making it a mainstay for growers in South Africa and abroad. *F. natalensis* makes up one of the largest groups of species in the SUBG collection, comprising around 10 percent.

Another African species that has become very popular for bonsai is *Olea europaea* subsp. *africana* (syn. *O. e.* subsp. *cuspidata*), a subordinate taxon of the commonly known European olive tree. The distribution of this subspecies ranges widely from Africa through the Middle East, India, and China. It is widely grown in parks and urban environments for its stress tolerance and cold hardiness (Joffe 2002). The species displays small, lustrous, evergreen leaves that form dense canopies, and greenish white

Popular South African Styles

Of the six styles described by Charles Ceronio, the three that have gained widespread adoption in South Africa are the flattop, Pierneef, and baobab styles (Adam 1992, Ceronio 1999).

Baobab style

This style focuses on mimicking the iconic African baobab tree (*Adansonia digitata*). Baobabs in the wild are considered to be one of the world's largest trees, not for their height, but for their impressive girth. These trees tend to grow with massive central trunks giving away to relatively short branches. Adapted to growing in regions with high summer temperatures, the genus is found throughout tropical Africa and Madagascar. For the baobab bonsai style the focus is placed on the upright trunk habit, giving the impression of a large central section while the branches are kept short. Seldom seen in collections, this style can be accomplished by using taxa such as the African baobab itself, corkwood (*Commiphora* spp.), or coral tree (*Erythrina* spp.). In order to convincingly emulate the thick trunk, bonsai trainers often select several upright stems and use twine or wire to pull the multiple stems together, thus fusing them into a single trunk. This style was principally developed by Charles Ceronio.

MILES S. SAX

A baobab (*Adansonia digitata*) growing in South Africa's Kruger National Park.

REBECCA PRETORIUS

A 28-year-old baobab bonsai created by article co-author Willem Pretorius.

Pierneef style

The Pierneef style is an open umbrella-shaped tree form. It invites the viewer to imagine the tree spreading wide over an expansive savanna landscape. The umbrella form itself is created by the tight zigzag branching pattern reminiscent of acacia species, such as *Acacia sieberiana* (syn. *Vachellia sieberiana*), found throughout Africa. The style was named after South African artist Jacobus Hendrik Pierneef (1886–1957) whose paintings often focused on landscapes, portraying them with dramatic flair and strong geometric overtones. Bonsai in this style favor leaning or naturalistic curved trunks. Single specimens or grouped trees can be trained in the Pierneef style and the overarching branching pattern can be adapted to multiple layers in the tree's canopy. African plants used for the Pierneef style include *Acacia* species, *Olea europea* subsp. *africana*, and *Buddleja saligna*.

Flattop style

The flattop style is similar to Pierneef except that it lacks the drooping umbrella branches. This style is also very reminiscent of open savanna *Acacia* species. The form is exactly as the name states, branching upwards to form a horizontally expanding canopy, with short branch growth. The same species used to create Pierneef style bonsai can be used for the flattop style.

SUBC

Louis Nel's *Buddleja saligna* bonsai trained in the Pierneef style.

COURTESY OF TRANSNET FOUNDATION WITH SPECIAL THANKS TO THE RUPERT MUSEUM, STELLENBOSCH

***Mpumalanga*, a painting by South African artist Jacobus Hendrik Pierneef, shows the umbrella-like tree forms often seen in his works.**

flowers borne in axillary panicles. These combined characteristics make for a fine bonsai subject and *Olea europea* subsp. *africana* has become widespread in use. The earliest known African olive bonsai in the SUBG collection (accession # 2012-178) was from Gerjo van der Merwe and was started in 1960.

Over time an assortment of African tree species have been trialed for their use as bonsai and subsequently entered the collection. These have included taxa such as *Sideroxylon inerme*, an evergreen tree with lustrous, leathery leaves and round, purple-black fruits (specimen by van der Merwe from 1957); the kei apple (*Dovyalis caffra*), a spiny evergreen shrub with edible fruit (specimen by Wim Tijmens from 1960); *Gardenia thunbergia* (specimen by Becky Lucas from 1960); *Acacia galpinii* (specimen by Becky Lucas from 1964); and *Grewia occidentalis*, a sprawling evergreen shrub with pretty lavender pink flowers (specimen by Louis Nel from 1981). The use of unconventional trees for bonsai displays a spirit of exploration and nonconformity that is ever-present in South African culture.

The South African Bonsai Styles

One of the most curious elements of South African bonsai is the development of a series of distinctive styles that are unique to the plants and horticulture of the country. These bonsai interpretations diverge from the traditional styles found in China and Japan, giving rise to elegant forms seldom encountered in the world of miniature trees. The derivation of the South African bonsai styles comes from interpretation and mimicry of the architecture of an assortment of quintessentially African trees. These African styles are the Pierneef, the baobab, the flat top, the bushveld or natural, the wild fig, and the wonderboom ("boom" means tree in Afrikaans). South African bonsai expert Charles Ceronio is credited for development of many of these styles and he writes about them in detail in his book *Bonsai Styles of the World*.

Traditionally, trees selected to be used for bonsai are chosen because of particular desirable phenotypic characteristics such as small leaves or a unique branching habit. These characteristics give the trees the proper dwarfed effect in their mature states. Some plant species

MILES S. SAX

The iconic umbrella-like form of *Acacia* is emulated in several South African bonsai styles.

from the South African flora are used to create bonsai that emulate the forms of other South African species. For example, *Buddleja saligna*, which grows as a shrub or small tree, has been expertly crafted into bonsai that mimic the form of the much larger paperbark thorn (*Acacia sieberiana*, syn. *Vachellia sieberiana*). The paperbark thorn, with its dominantly spreading, umbrella-like branches, is often cited as inspiration for the flattop and Pierneef styles of bonsai. The SUBG collection holds numerous excellent examples of these styles created from *Buddleja saligna*. When observing shrubby *B. saligna* in the wild one would not necessarily imagine it to be well suited for bonsai, but with its fine-textured silvery green leaves, the species proves to work exceptionally well. While *B. saligna* makes for fine architectural shaping,

SUBG

Many plant species and bonsai styles are on display in Stellenbosch University Botanical Garden's bonsai house.

there is some question as to the longevity of this tree for bonsai because of the shrub's soft wood. The collection of *Buddleja* specimens at SUBG will stand as a long term trial of the species' suitability as a bonsai subject. Just over 10 percent (23 of 213 specimens) of the collection is made up of this single taxon.

The Western Cape Heritage Bonsai Collection Today

The collection has been looked after for the past 25 years by volunteers, mostly from the local club called Boland Bonsai Kai. The club members meet monthly and have workshops in the botanical garden. Beginners are trained separately at different workshops by senior members. This year the fourth African Bonsai Convention will be hosted in Stellenbosch. It will also be the first time that the directors of the World Bonsai Friendship Federation will meet in Africa. There will be a number of bonsai craft demonstrators from the United States, France, and England. The club will have tours during the conference to introduce visitors to the collection. It is an exciting opportunity to showcase the best bonsai Africa has to offer.

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Miles S. Sax is a PhD student at Cornell University in the Horticultural Science Section. He was the recipient of the 2014 Frederick Dreer Scholarship, which he used to travel to South Africa to study the flora and to work at Stellenbosch University Botanical Garden.

Willem Pretorius is the current chairman of the South African Bonsai Association, the Western Cape Bonsai Forum, and Boland Bonsai Kai. A retired journalist and writer, he is a keen bonsai enthusiast who has traveled to Japan, China, Europe, and Namibia on bonsai tours.

Tracking the Seasonal Rhythms of Boston Common Trees

W. Wyatt Oswald and Andrew D. Richardson

New England's deeiduous forests undergo dramatic seasonal ehanges. New leaves emerge from proteetive buds as winter gives way to spring, green trees eoneeal the landseape and east deep shade during the height of summer, and glorious fall foliage senesees as autumn yields to the snows and bitter eold of winter. But how mueh do these seasonal transitions vary from year to year? We are exploring this phenologieal question through detailed observation of a setting familiar to many New Englanders and visitors alike—the Common in downtown Boston. Sinee mid May of 2010, a digital eamera mounted on the roof of the ten-story Walker Building, overlooking the Boston Common from the campus of Emerson College, has taken photos at thirty-minute intervals of a tree-covered area on the east side of this historie park.

The images generated by digital eameras represent eolors using the RGB (red, green, blue) additive eolor model, whieh proposes that any color pereeived by the human eye ean be represented by some eombination of these three primary eolors. Eaeh digital image is aetually eomposed of three separate layers, one eaeh for red, green, and blue. We eharaeterize the "greenness" of the tree eanopy by using image analysis software to measure how bright the green layer is relative to the total brightness of the red, green, and blue layers together. The eolor of the eanopy is related to the eolor of individual leaves, as well as to the number of layers of leaves in the eanopy. Individual leaf eolor is largely determined by pigments—green

ALL IMAGES BY THE AUTHORS UNLESS OTHERWISE NOTED

Photos of the Boston Common in spring (April 30, 2011), summer (July 1, 2011), fall (November 11, 2011), and winter (February 5, 2012).

chlorophylls, orange carotenoids, and red anthocyanins—but is also an indicator of photosynthetic capacity (Richardson et al. 2007; Sonnentag et al. 2012).

When we use this approach to quantify the greenness of all of these photos of the Common we can visualize the seasonal shifts. Following budburst, leaves expand rapidly and the springtime green-up happens quickly. Over a span of just four weeks, the leaf-out of deciduous elms, basswoods, cherries, and maples transforms the Common from a late winter landscape of browns and grays to its maximum greenness, which generally occurs during the first half of May. Peak green lasts only a couple of weeks, though, because as leaves mature they actually darken somewhat (Keenan et al., 2014). This causes a gradual reduction in our greenness index over the course of the summer. Then fall arrives: day lengths get shorter, temperatures become colder, and chlorophyll production gradually slows down. Greenness fades with the onset of senescence, leaf coloration, and leaf fall. The timing of these autumnal changes varies from species to species, and thus the de-greening of the Boston Common landscape happens somewhat more slowly than spring leaf-out, taking about six weeks from start to finish.

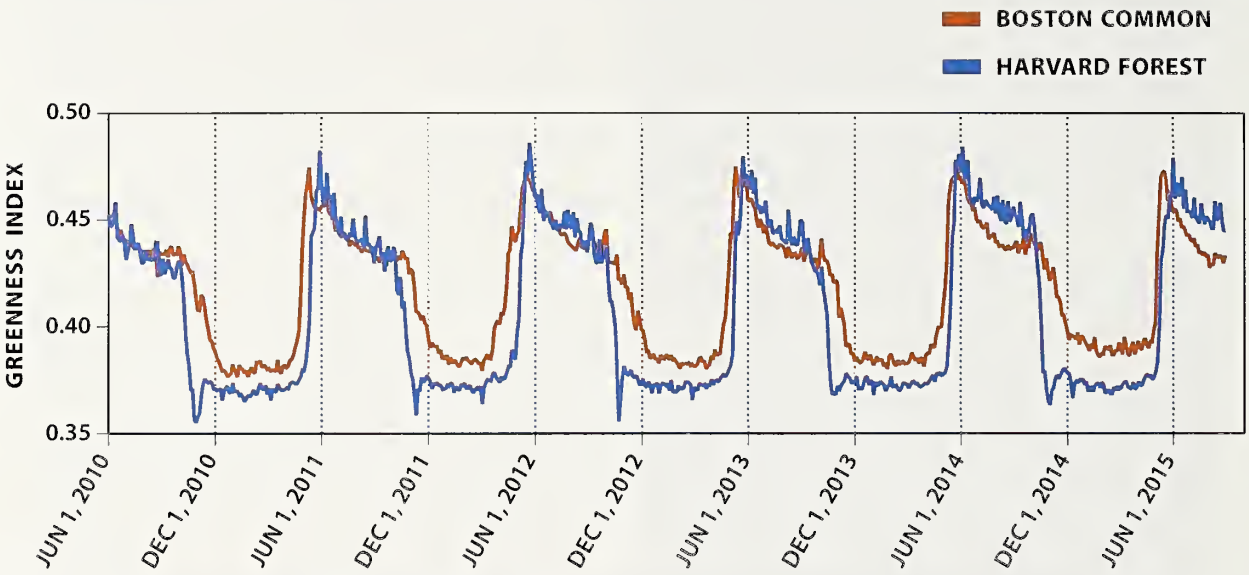
Comparison of the Boston Common data with those from a similar camera at Harvard Forest, located in the north-central Massachusetts town of Petersham, illustrates the general similarity of vegetation phenology in deciduous forests across southern New England. Despite differences in species composition between the native flora of Harvard Forest and the human-constructed mixture of native and nonnative tree species that we find in the Boston Common, both landscapes feature rapid spring green-up and maximum greenness at the beginning of the growing season. However, since Harvard Forest is situated more than 300 meters (984 feet) higher than Boston, nearly 100 kilometers (62 miles) inland, and well outside the urban heat island (Zhang et al. 2004), it is cooler than the Common and thus has a shorter growing

About Boston Common

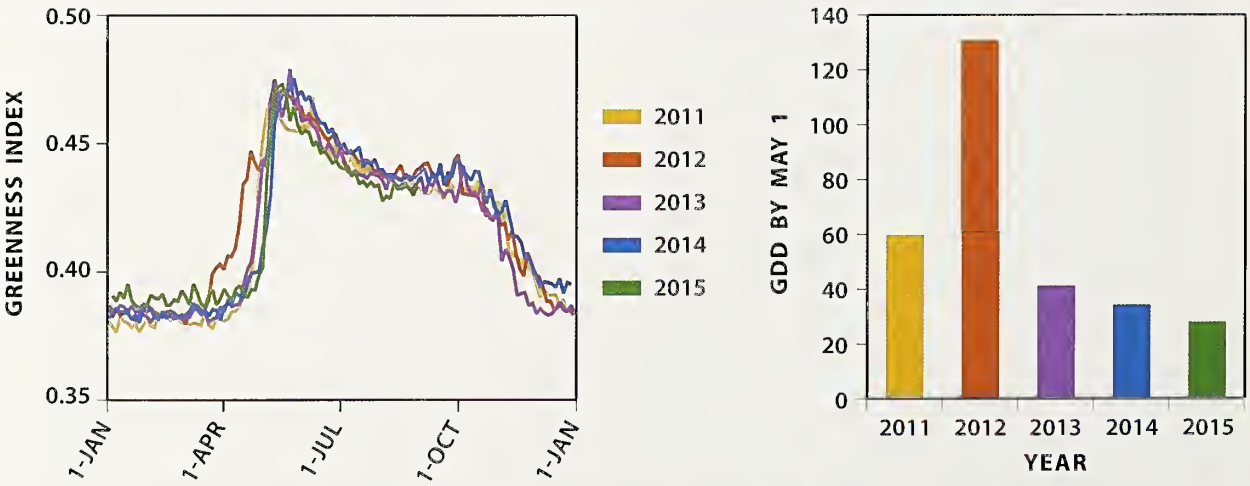
Since its founding in 1634, the fifty-acre Boston Common has served many purposes. In the seventeenth century, the sparsely wooded Common was used as a pasture for cattle. Early maps show only three trees, including the Great Elm, a majestic tree that loomed over the Common until it was blown down in a windstorm in the winter of 1876. The Common began to take on parklike qualities early in the eighteenth century. Bostonians strolled along wide, tree-lined malls, the first of which was established along Tremont Street in 1722. During the American Revolution and War of 1812, however, hundreds of soldiers were based in Boston and large encampments were built on the Common. Cows were eventually banned in 1830, and with subsequent formal landscaping the Boston Common was transformed to the largely forested park that exists today (Friends of the Public Garden 2005).

COURTESY OF HISTORIC NEW ENGLAND

This 1845 engraving by Hammatt Billings shows the Great Elm growing in the Boston Common.



Seasonal shifts in greenness for Boston Common in downtown Boston and Harvard Forest in Petersham, Massachusetts, between June 1, 2010 and September 1, 2015.



Leaf-out in the Boston Common occurred much earlier in 2012 than in the other years between 2011 and 2015. Springtime temperatures were anomalously warm in 2012, as reflected by the high number of growing degree days (GDD) reached by May 1 of that year.

season. With earlier leaf-out and later leaf drop, trees in downtown Boston have green leaves some eight weeks longer than their counterparts in Petersham.

Now that we have captured the vegetation phenology of five springs in the Boston Common photos, we can see how the timing of leaf-out has varied across years with strikingly different weather conditions. All but one of the years have a similar pattern: in 2011, 2013, 2014, and 2015, leaf emergence at the Common started at the beginning of April and greenness increased steadily over the next five weeks or so. In contrast, early spring temperatures in 2012 were significantly warmer than normal (Friedl et al. 2014), with record-breaking heat in Boston during the middle of March. The trees of the Boston Common responded immediately to this unseasonable warmth, leafing out within just a few days. As a result, the 2012 growing season was about a month longer than the other years for which we have photos.

The first five years of data from the Boston Common are consistent with other phenology studies in showing that the green-up of deciduous trees is highly sensitive to climatic variability (Cleland et al. 2007). If the warmth of March 2012 gives us a sense of what the future holds for springtime in Boston, as climate projections suggest (Hayhoe et al. 2007), then we can expect earlier leaf-outs and a substantial lengthening of the growing season. A failure to track these changes could be deleterious to the insect, bird, and mammal species that utilize urban forests as habitat. Such an outcome also has consequences beyond the Boston Common: phenological changes have the potential to shift competitive interactions among tree species and affect the carbon balance of forest ecosystems (Keenan et al. 2014). To better anticipate these dynamics, our research on vegetation phenology and related ecological processes will continue for years to come at the Boston Common, Harvard Forest, and dozens of other sites where this type of study is being carried out as part of the PhenoCam Network (phenocam.sr.unh.edu/webcam). More broadly, as Aldo Leopold put it, "phenology may eventually shed some light on that ultimate enigma, the land's inner workings" (Leopold and Jones 1947).

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W. Wyatt Oswald is Associate Professor of Science at Emerson College and Andrew D. Richardson is Associate Professor of Organismic and Evolutionary Biology at Harvard University. This work has been supported by Emerson College and the National Science Foundation through the LTER (DEB-1237491) and Macrosystems Biology (EF-1065029) programs.

A Study in Scarlet: *Nyssa sinensis*

Nancy Rose

My favorite "old reliables" for fall color at the Arboretum include the pure gold foliage of sweet birch (*Betula lenta*), the fiery red-orange-yellow display of Korean maple (*Acer pseudosieboldianum*), and the glossy burgundy leaves of *Euonymus carnosus*. That's just a start, though, and one of the delights of wandering the Arboretum repeatedly in autumn is discovering new spots of color. A few years ago, on a gray mid-November day when many trees were already bare, I was drawn to a cluster of brilliant scarlet and orange leaves remaining on a tree branch. The tree, it turned out, was Chinese tupelo, *Nyssa sinensis*.

This was a new species to me, but I certainly knew another species in the genus, *Nyssa sylvatica*, known by the common names sour gum, black gum, tupelo, black tupelo, pepperidge, or, to residents of Martha's Vineyard, beetlebung. Under any name, this eastern North American species is a handsome tree, noted for its lustrous green foliage that turns stunning shades of red in the fall. Though its native range is thousands of miles away, Chinese tupelo is strikingly similar to sour gum, providing yet another interesting example of the disjunct floras of eastern North America and eastern Asia.

Chinese tupelo is slightly smaller than sour gum, growing as tall as 60 feet (18 meters) in the wild but in cultivation typically reaching only 30 to 40 feet (9 to 12 meters). It has a pyramidal to upright-oval form and dark gray, irregularly fissured bark. Chinese tupelo is deciduous; when its leaves emerge in late spring they often have an attractive red or bronze tint. Mature leaves are about 4 to 6 inches (10 to 15 centimeters) long, dark green and slightly shiny above, lighter green below. Autumn foliage color may be variable depending on individual plant and local climate, but typically ranges from light yellow and apricot to bright, almost luminous reds and oranges.

As with other *Nyssa* species, Chinese tupelo is primarily dioecious (male and female flowers borne on separate plants) but some plants may also bear a few perfect (having both male and female parts) flowers. Female flowers are borne in axillary clusters and male flowers are produced along older branches. The small greenish flowers are inconspicuous but they are extremely attractive to honeybees (*N. ogeche*, which has a limited native range primarily in southern Georgia and northern Florida, is the source for prized tupelo honey). The fruit of Chinese tupelo is a dark blue oblong drupe that is readily eaten by birds.

Taxonomy references place *Nyssa* either in Cornaceae (the dogwood family) or in its own family, Nyssaceae. The genus name *Nyssa* comes from Greek mythology and refers to a water (or rain) nymph named Nyssa (or Nysa), one of the nymphs who cared for Dionysus, god of wine, as a child (the location where the water nymphs sheltered Dionysus and where he invented wine is known as Mount Nyssa). The reference to water is the important bit, since this alludes to the preference of all *Nyssa* species for moist soils. The type species for the genus is in fact another North American species, *N. aquatica*, commonly called water tupelo or swamp tupelo because it grows in very wet sites. Like its American relative, *N. sylvatica*, Chinese tupelo prefers evenly moist, acidic soil but also tolerates somewhat drier conditions.

The Arboretum currently holds just one specimen of Chinese tupelo (*N. sinensis*, accession 374-81-B), which grows near several other *Nyssa* accessions near Rehder Pond. This accession was received as seeds from China's Hangzhou Botanical Garden in 1981, but the exact provenance of their collection is unknown. Chinese tupelo has a fairly large range in central to southern China and an individual tree's cold hardiness may vary with provenance, but a probable hardiness rating would be through USDA Zone 6b (average annual minimum temperature 0 to -5°F [-17.8 to -20.6°C]). Though unlikely to supersede our native sour gum as a landscape plant, Chinese tupelo does offer a wonderful burst of color as autumn moves toward winter.

Nancy Rose is the editor of *Arnoldia*.