



The Arnold at 150

By William (Ned) Friedman

hat is the Arnold Arboretum? This question has been at the center of my thinking for over a decade, especially now, as I enter the twelfth year of my directorship and the Arnold enters its 150th year. Of course, nothing should ever be static when it comes to the life of an institution. Founding nineteenth-century ideals need updating in the twenty-first century. Still, for all that has changed over the last century and a half, the core values of the Arnold Arboretum strike me as eternal.

The Arnold Arboretum has and will always serve as a crossroads for biodiversity and human diversity. Its founding was a testament to the enduring values of democratic spaces (free and open to all) and the belief that such places should uplift all who enter. The Arnold is also, from the outset, an institution defined by its association with Harvard University. Scholarship, born of a love of biodiversity and a desire to unlock its secrets, is central. An ethos of conservation and respect for the environment goes back to the founders and early leaders. The meanings of such an intermingling of sentient and nonsentient organisms (respectively, people and trees) can never be fully unpacked, even in a lifetime of pondering. Yet I will briefly reflect on my thinking.

Let's begin with my definition of an arboretum: a collection of woody plants with provenance in a designed landscape. Here, *provenance* and *designed landscape* are essential characteristics that help us appreciate the varied and dynamic relationships that occur between people, uniquely identified botanical organisms, and arboretum landscapes. The concept of provenance is typically associated with museum objects (think artworks), and at the Arnold Arboretum, every organism has a documented and acknowledged history. Take, for example, a single specimen of the sand pear (*Pyrus pyrifolia*, accession 7272*C) that has grown on the top of Bussey Hill for over a century.

We know that Ernest Henry Wilson and his collecting team encountered the parent of this sand pear growing west of Yichang, China, in the late summer of 1907. They collected fruit, removed its pulp (perhaps by eating it?), and separated, dried, and packed the seeds. The packet then passed as cargo down the Yangtze River to Shanghai, made its way by steamer to the west coast of North America, and took the transcontinental trains to Boston. On April 15, 1908, an Arboretum propagator formally accessioned the seeds. A few years later, a spot for a young sapling was chosen, and a hole was dug. This wonderful organism has lived in this location ever since, battling plant diseases and delighting visitors with its extraordinary clouds of white flowers every spring. This specimen is not *any* sand pear. It is an individual with its own life history and standing, not interchangeable with any other sand pear on Earth, just as no two human beings are interchangeable. Such provenance—granular and unique—distinguishes almost all the Arboretum's roughly sixteen thousand accessioned woody plants.

A designed landscape is also central to my definition of an arboretum, and the Arnold Arboretum is fortunate to have been designed by a visionary-Frederick Law Olmsted. His intentional design is reflected in every inch of the grounds, like the majestic reveal as you round the bend on Hemlock Hill Road and unexpectedly view the dramatic mixture of spruces and firs, with their blues and seemingly endless hues of green. The intentionality can be felt as you stand under the cathedral-like oak collection or take in a seemingly endless run of mountain laurels in flower in the spring. This landscape was designed to affect us and, indeed, to lift our spirits every day.

The impact of these experiences is profound. Olmsted spoke of the power of institutions like the Arnold Arboretum "to make life in the city healthier and happier." But, surely Olmsted, despite his public health credentials (as general secretary of the US Sanitary Commission during the Civil War), would never have dreamed of the slew of well-documented health benefits of beautiful urban green spaces such as the Arnold Arboretum. Those who regularly walk these grounds may experience (on average) lower blood pressure, improved postoperative recovery, improved birth outcomes, improved outcomes associated with congestive heart failure, improved child development, reduced mortality, reduced stress, reduced symptoms of attention deficit hyperactivity disorder, reduced depression, and greater life satisfaction-the list goes on. The Arnold Arboretum is literally interwoven into the healthcare system of Boston.

On a global scale, the research and conservation functions of the Arnold

The Arnold Arboretum is literally interwoven into the healthcare system of Boston. Arboretum have never been more critical. Fully three-quarters of the research now being conducted in the living collections is centered on understanding and combating human-induced global change, including climate change. How will trees and forested ecosystems function going forward, as climactic extremes mount by the year and invasive pests and pathogens circle the globe? The Arnold's "working" collection of woody plants is on the job providing essential insights into the coming biological Armageddon. Our plant expeditions throughout the temperate regions of the Northern Hemisphere emphasize the collection of germplasm from species and populations that are threatened with extinction. *Ex situ* conservation, the maintenance of living collections of endangered plants in botanical gardens and arboreta, has never been more critical to the Arnold's mission and to Earth's botanical biodiversity.

I could go on but will finish by reflecting on the last two years of the Arnold Arboretum's existence. Through a raging and lethal pandemic, a reckoning over systemic racial injustice, an insurrection and serious challenge to American democracy, and the evermore obvious extreme fires, floods, droughts, heat waves, and other threats to the world's four-billion-year evolution, the Arnold Arboretum did not close for a minute.

The Arnold Arboretum is not a mere amenity or simply a pleasure ground. It is an essential part of the public healthcare system, a place where the diverse population of Boston mixes, a bulwark for democracy, a leader in fighting global change and extinction, and a place where the next generation of ecologists, evolutionary biologists, and conservationists will launch their careers. And standing behind all of this are the magnificent plants with provenance in an Olmsted-designed landscape. What could possibly be more beautiful and meaningful as the Arnold Arboretum launches into its next century and a half? *#*

WILLIAM (NED) FRIEDMAN is the eighth director of the Arnold Arboretum and the Arnold Professor of Organismic and Evolutionary Biology at Harvard University.

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Beijing Botanical Garden's Kang Wang blazes the trail while on expedition in Sichuan in 2017. Photograph by Michael S. Dosmann



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Plants of Record

IFTTFRS

The Arboretum is hallowed ground, replete with the *A*-to-*Z* litany of hardy trees and shrubs for study, research, enjoyment, and spirituality. In 1972, I first visited the Arnold, and fifty years later, the Arnold continues to be a part of my horticultural life.

I was honored to spend two sabbaticals at the Arnold: the first in 1978 and 1979, the second in 1991. I have returned many times, the most recent in July 2021. My writings, including the Manual of Woody Landscape Plants, are peppered with observations and facts derived from the world-class curated collection of woody trees and shrubs. Jack Alexander-the Arnold's long-time plant propagator, now retired—once commented that no institution maintained better plant records. Plant trueness-to-type is documented, along with information on the collector, date, origin, et cetera. These records are the bedrock of the Arnold's botanical and horticultural greatness.

Michael A. Dirr

Professor emeritus, University of Georgia Oconee County, Georgia

Next Generations

Elizabeth Russell-Skehan's recent essay in issue 78(5–6) on the five generations of the Russell's Garden Center is a reminder that passing along horticultural businesses in a family line is something to be championed. Just the other day, some colleagues and I were lamenting that none of our children are interested in gardens or horticulture and especially not interested in following in our footsteps. That doesn't mean that they aren't doing good things. (My only child is currently at the University of St. Andrews in Scotland, earning a master's in neuroscience.) All it means is that we need to be intentional about mentoring other kids who are interested in the world of plants.

Esther Truitt Henrichsen Garden Designer, Thanksgiving Point Lehi, Utah

Lab Read

At our first lab meeting of the semester, we discussed the *Viburnum* paper that Michael Dosmann and Anthony Aiello wrote for *Arnoldia*, issue 76(4). Can I just say, what an incredible way to kick off the semester! I have three new students, and I have never had any new student, let alone all three, talk so much on the first day—so fantastic!

The group was struck by the history of trying to cultivate these plants at the Arnold and elsewhere and related that part of the article to thinking about how experiments can fail, and, well, that's just part of science. They got goosebumps thinking about Asa Gray and Darwin. And to my delight, they were really into reading about the *Pseudotinus* species: the history of how Can I just say, what an incredible way to kick off the semester! they came to be described, why this history is relevant to our research today, and why it took so long to realize the phenomena of disjunct distributions. Overall, though, having the opportunity to read about our collaborators in the field, doing and experiencing science, and sharing that in this format was striking.

Wendy Clement

Associate Professor, The College of New Jersey Ewing, New Jersey

Trees of Nikko

I have too many stories about what makes the Arnold Arboretum special to me. I cannot choose just one, but one of my favorite Arnold experiences occurred in Nikko, Japan. I happened to visit a few weeks after reading an *Arnoldia* article about an early plant explorer's visit to Nikko, and I recognized trees in the landscape today from the photos taken a century ago. The Arnold's blend of history, art, design, botany, ecology, and geography never fails to stimulate and delight. *Patricia Suhrcke Roslindale, Massachusetts*

Lilac Sunday



Mark your calendars for a special sesquicentennial edition of Lilac Sunday. This springtime tradition at the Arnold Arboretum will be celebrated with tours, hands-on children's activities, and other programming on Mother's Day: May 8, 2022. Celebrated by Bostonians for well over a hundred years, Lilac Sunday is an opportunity to explore the Arboretum's nationally accredited collection of lilacs (*Syringa*)—a fragrant array of pinks and purples, whites and mauves. Given the fanfare of the Arboretum's sesquicentennial, plant explorer Ernest Henry Wilson's remark about "Lilac Time" couldn't seem more appropriate: "Let us go to the Arboretum!"

Visit arboretum.harvard.edu

Notes from the Field

Planting the New Lions of Kew

Tony Kirkham finds planting opportunities within a centuries-old landscape.



Tony Kirkham

retired as head of the arboretum at Royal Botanic Gardens, Kew, in the summer of 2021. Among other honors, he was appointed to the Most Excellent Order of the British Empire in 2019. A shead of the arboretum at the Royal Botanic Gardens, Kew, I would walk the collection each day, choosing a different route and corner of the three-hundredacre landscape. On the walks, I observed the growth of newly planted trees and built up a knowledge of the collection. I wanted to understand where gaps occurred and what we should plant to improve the wealth and diversity of the woody collections. I kept an eye out for important but ailing plants that should be repropagated. This daily practice remained valuable no matter how long I worked at Kew—a tenure that spanned forty-three years in various roles. I describe the arboretum at Kew as a living reference library of woody plants from every corner of the temperate world that will grow outdoors (near London) without any form of protection during the winter. However, overseeing a collection like this isn't just about planting trees as they become available and looking after them. The collection is visited by two million people per year. It must meet the demands of a school educational program and remain one of the most diverse and authentic scientific collections of temperate trees in the world.

The age of Kew only adds to the challenge: how does a curator not only maintain but hopefully improve upon a tree collection that has been tended for more than 250 years? The gardens at Kew date to 1731, when King George II's son, Frederick Prince of Wales, leased the estate and began to develop the grounds. After his death, his wife, Princess Augusta, continued his work, and in 1759, on the advice of Lord Bute, her horticultural advisor, she created a nineacre botanic garden with the planting of several newly introduced trees that we now know as the "Old Lions." Some of these are still growing today, including a maidenhair tree (Ginkgo biloba) and a black locust (Robinia pseudoacacia). By 1768, the collection included almost five hundred hardy trees and shrubs, but it wasn't until 1840 that Kew Gardens was placed under direct government control and the first director. William Hooker, was appointed to restore and expand the arboretum.

It has been an amazing privilege to oversee such a collection, following in the footsteps of remarkable people like William Jackson Bean, the assistant curator of the arboretum between 1900 and 1922. He authored the monumental reference work *Trees and Shrubs Hardy in the British Isles,* which is now online (with regular revisions) as Trees and Shrubs Online, courtesy of the International Dendrology Society. Even within such a storied landscape, the collections are ever-changing. Managing those changes is the essential work of a curator.

A landmark turning point for the arboretum occurred on the night of October 16, 1987, when a hurricane struck the southeast of England, wreaking havoc to trees and woodlands, felling over fifteen million trees in its wake. At Kew, over seven hundred mature trees were lost that night. I remember waking up to loud bangs and crashes and my steel dustbin rolling down the road. I got up to retrieve it and was concerned by the strength of the winds. The following morning, all came to light with the news showing images and footage of devastation across the south of England.

I was a young supervisor in the arboretum at the time, and when I finally made the journey into work, I immediately went out into the landscape to see how all my arboreal friends had fared through the night. Even within such a storied landscape, the collections are everchanging. As I picked my way through the limbs and uprooted trees, all I could think was "doom and gloom." It took us over three years to finally clear away the fallen, damaged trees. As I look back now, I consider this hurricane to be one of the best things that happened in the twentieth century for trees in the United Kingdom. It raised public awareness of the importance of trees nationally. At Kew, a new plant exploration program was started to replenish the gaps in the collections created by the storm, and new arboricultural practices were developed to improve the health of the remaining trees.

I was fortunate to be a part of the team sent to collect new documented seed material to rebuild the tree collections. The species on the target lists and the parts of the world that would be visited were determined by an audit of what was still represented in the collections after the storm, looking at the taxonomic and geographic weaknesses. The first expeditions were to western China, South Korea, Taiwan, the Russian Far East, and Japan, and



FROM THE LAB A Home for *Heptacodium*

Introduced to the Arnold Arboretum (and North America) in 1980 and now a late-summer-blooming garden favorite, the Chinese seven-son flower (*Heptacodium miconioides*) finally has residency among its relatives. In 2021, scientists from The College of New Jersey and Yale University published in the *American Journal of Botany* on phylogenetic relationships in the Dipsacales, a group of several plant families, forty-four genera, and more than one thousand species.

Though well understood to be a member of the honeysuckle family (Caprifoliaceae), *Heptacodium* evaded further placement: was it more closely related to snowberries (*Symphoricarpos*) and honeysuckle (*Lonicera*), which reside among a group called Caprifolieae, or to another group, Linnina, that includes beautybush (*Kolkwitzia*) and dipelta (*Dipelta*)? The results are in, and despite morphological similarities (such as dried fruits) to others in Linnina, this dandy of the shrub border is more closely related to the fleshy fruited Caprifolieae. the material brought back over the past thirty-four years has greatly enriched the diversity and provenance of the tree collections. Much of this has not been done alone. Working with colleagues at other arboreta around the world has been important for sharing ideas, collections, and stories.

I have never been one for pushing the boundaries of hardiness, especially as we increasingly experience unpredicted weather patterns. Still, I have been able to plant and establish species that we could not have grown outdoors forty years ago: for instance, the Taiwan coffin tree (Taiwania cryptomerioides), Kashmir cypress (Cupressus cashmeriana), and the paraná and bunya pines (Araucaria angustifolia and A. bidwillii), both from the Southern Hemisphere. On my daily walks through the arboretum, I would look for locations to position these and others. As curators, we all have our favorite areas and genera of trees, but we must ensure that other parts of the collection aren't neglected. I found that the wire cages used to protect our young trees provided a helpful visual cue. The cages are retained for five years, so I would stand in the arboretum and turn 360 degrees. If I failed to see one of the cages, this would signal to me a target area for succession planting.

Several new introductions into the arboretum come to mind as highlights. In the autumn of 1996, on a collecting trip to China, I was fortunate to be granted permission to visit Jinfushan, a mountainous preserve in the upper reaches of the Yangtze River, to see the Chinese silver fir (Cathaya argyrophylla). This species, discovered in 1955 by Chinese scientists, was something we had only heard about but never seen. We found it growing on the limestone bluff but could not collect seed, owing to a national embargo. Two years later, the embargo was lifted, and seed was distributed to forestry institutes and botanic gardens. The Forestry Commission's Bedgebury Pinetum was the first to grow this tree in the United Kingdom, and its curator gave me a two-year-old plant for our collection. This can be a miffy species and finding the best planting position

This species, discovered in 1955 by Chinese scientists, was something we had only heard about but never

seen.

can be difficult. More by luck than judgement, I got it right. The plant at Kew is now a beautiful specimen about twenty feet high. It has produced viable seeds, and the first generation of *ex situ* propagated seedlings has now been planted out in the arboretum, helping conserve this rare tree.

Another successful introduction is the Chinese hickory (Carya cathayensis). In 2008, on a trip to China to follow in the footsteps of Ernest Henry Wilson, I visited a market in Shanghai and saw nuts of the rare species being cooked and sold as candied pecans. We bought a kilo of uncooked seeds, and the propagator in Kew's nursery, after much experimental work, successfully germinated the seed and grew over twenty plants that are now sited in various locations across the arboretum. These are now gorgeous trees. They are very well-behaved, needing little if any formative training and producing a straight tapered trunk with an even distribution of lateral branches. The species is perfectly hardy in the United Kingdom.

For me, one of the main criteria for a successful and healthy treescape and collection is continual succession planting, maintaining a healthy population with generations of individual species, like a family, ranging from the great grandparents (the Old Lions) to the great-grandchildren (the newly planted trees this year). It was so rewarding to walk the collections seeing new introductions like the delicate Taiwan beech (Fagus hayatae), which we introduced as seed to the West in 1992, growing into strong, attractive specimens and enhancing the conservation value of the arboretum. Some of these, we hope, will be the Old Lions of tomorrow. 🧶





Plant Rescue on the Cliffs of O'ahu

Nellie Sugii explains how micropropagation saved a critically endangered Hawaiian shrub.

n 2004, the last remnants of an exceedingly rare Hawaiian species, Cyanea gri*mesiana* ssp. grimesiana, bloomed and set fruit in the wild. Known only from the leeward slopes of the southern Koʻolau Mountains on the island of O'ahu, this shrub is one of seventy-eight species within an endemic Hawaiian genus commonly known as hāhā. The species could be found surrounded by koa (Acacia koa) and other common forest trees, and it has been rare since it was first documented in the wild in 1819. Significant surveys occurred in the 1990s, and by 2004, only two mature wild plants remained, with no evidence of recruitment or any significant ex situ collections. The situation became dire.

At the time, I was several years into my career as a researcher for the Lyon

Arboretum's Hawaiian Rare Plant Program, where I'm now the program manager. Our work focuses on rescuing and recovering Hawai'i's most critically endangered plants, storing germplasm for *ex situ* conservation, and providing plants for *in situ* restoration. Our micropropagation laboratory is central to this effort—a surreal indoor space where more than 170 of Hawai'i's rarest and endangered plant species are grown collectively in tens of thousands of test tubes. I often describe it as "plant conservation through the looking glass."

When the hāhā remnants flowered, our team worked with collaborators, including the Plant Extinction Prevention Program, the US Fish and Wildlife Service, and the US Army's Natural Resource Program, to plan for protecting the species in the micropropagation facility. Field biologists monitored the two plants. The flowers emerged as white, arching tubes, streaked with vibrant purple. The fruits then ripened into orange, fleshy capsules. The biologists carefully collected the fruit and brought it to the micropropagation lab for germination. We knew it was a heavy responsibility when the precious seeds arrived, but excitement ran through the lab as we sorted, cleaned, and prepped the seeds for in vitro seed sowing.

Micropropagation gained recognition as

Nellie Sugii is the acting director

Arboretum, part of the University

of Hawai'i, and is

the Hawaiian Rare

the manager of

Plant Program.

of the Lyon

a viable propagation method for commercial applications in the 1960s, but the technique was initially viewed suspiciously due to associated terms and applied technologies such as cloning, anexic seed sowing, ovulo culture, and organogenesis. To some, even at the Lyon Arboretum, these technologies seemed contrary to conservation theologies of preservation and genetic integrity. Yet micropropagation has gradually proven itself as a useful rescue and recovery tool. It can be used to germinate immature seeds and rescue embryos from aborted fruit. It's also used for cloning wild plants at risk of extirpation in order to preserve genetic representation and establish clonal lines of its seedling progeny for restoration.

After the hāhā germinated in our lab, we learned that the final wild remnants had altogether succumbed—the species no longer existed in the wild. This knowledge brought bittersweet feelings as we watched the seeds germinate in the petri dishes and eventually grow into seedlings that we placed into individual test tubes. We knew that it was now our responsibility to establish perpetuity for this species by establishing clonal lines of the seedlings through microcuttings and maintaining the *in vitro* germplasm collection until a safe and secure restoration site free of threats became available.

Approximately 88 percent of the native plants on the Hawaiian Archipelago naturally occur nowhere else in the world. This rich biodiversity serves as a unique example of insular evolution, but its fragility is evident by the scale of species on the brink of extinction. According to listings by the US Fish and Wildlife, about one-half of the nation's threatened and endangered plant taxa are from Hawai'i. Of the five hundred Hawaiian species assessed for the International Union for Conservation of Nature's Red List, about 87 percent are classified as endangered or threatened. Let us not mention the hundreds of rapidly declining species that are missing from either list but are at risk of extinction.

On August 23, 2013, over nine years after the eventful collection date, I gathered at a

We learned that the final wild remnants had altogether succumbed the species no longer existed in the wild. site in the Koʻolau Mountains with a group of individuals involved in the conservation of *Cvanea grimesiana* ssp. *grimesiana*. A festive mood spread among us. We had long awaited the moment when we would bring this species and a few associated plants back to its native habitat, within the Manoa Cliff Forest Restoration site. Our small group of friends and family-even a few children-made our way through a forest of an invasive bamboo that had taken hold in the area. A few of our team wore backpacks containing plants. and most everyone else carried trays of plants or tools in our hands. A space opened in the bamboo, and a pocket (or kipuka) of near-intact native forest appeared before us. For those seeing it for the first time, the beauty of the area took our breath away. We all acknowledged that the enclosure represented a new beginning for this hāhā.

By 2021, the original Mānoa Cliff plantings had matured. The hāhā plants flower and produce fruit, and the seeds are collected and sowed for restoration purposes or stored in our program's seed conservation laboratory. We have now stored thousands of seeds from the different plants, and we continue to maintain the original clonal lines in the micropropagation lab, with long-term cryopreservation being our future and final *ex situ* storage goal. With many hands and great effort, we have brought *Cyanea grimesiana* ssp. *grimesiana* back home. *#*

WELL SAID

"Sometimes I need a whole morning to draw a tree. I move around it, I look at it from the front, from the side, from below, from above. All angles are good."

Botanist Francis Hallé, as quoted in *Trees*, a book by Fondation Cartier, reviewed on page 58.

Thinking Outside of the Quad

Carmia Feldman shows how a university reimagined its campus as a living laboratory.



Carmia Feldman serves as the assistant director of the UC Davis Arboretum and Public Garden. When Karyn Utsumi entered the University of California, Davis, majoring in environmental science and management in 2017, she didn't anticipate that she would eventually spend countless hours wearing waders and working with other students to restore a prominent water body on campus. Yet she knew that she wanted to turn her deep care for the environment into something that made a difference in her community. During her freshman year, she saw an announcement about the Waterway Stewardship internship with the UC Davis Arboretum and Public Garden. She applied and was thrilled to be selected.

The UC Davis Arboretum and Public Garden spans the entire 5,300-acre university campus, with a historic arboretum, founded in 1936, at the center. By applying the management and engagement principles of a

public garden to the campus at large, the university aims to enhance how the entire Davis community views and interacts with its environment. Our student internship program, which Karyn joined, is our top initiative to do just that-by developing the next generation of environmental leaders. The program is called Learning by Leading[™]. Students gain leadership and technical skills as they tackle critical environmental issues with real-world, hands-on projects. As students progress through the program, they take on more responsibility through our mentor-supported "leadership ladder." Students start as learners and then can work through a succession of leadership positions, including project leader, team leader, and apprentice.

For students in the Waterway Stewardship internship, their living laboratory is the Arboretum Waterway, a creek-like body of water that runs through the historic section of the arboretum. The waterway is part of the campus stormwater drainage system and is dammed at both ends. While it resembles a creek, the Arboretum Waterway is effectively a pond, which means that it comes with common pond issues: nutrient-rich water and unsightly algae formation. After Karyn was hired as her team's coleader during her junior year, she led her interns in developing a floating wetland with sedges and other native plants that take up nutrients from the water as they grow. From afar, the planting resembles a green island. She worked hard to create consequential experiences for her team, learning to see and celebrate each member's unique skills.

Over seven hundred students have now gone through the Learning by Leading program since it began in 2008. Another student, Ricardo Black, transferred to Davis from Los Medanos College, a community college in Pittsburg, California, for his junior year in the fall of 2019. He became a student leader for our Habitat Horticulture team, which enhances the suitability of campus gardens for native pollinators and other wildlife. Ricardo and his team worked in the Pollinator GATEway Gardens in the arboretum proper. A series of GATEway



OUT AND ABOUT More or Less in Common

When intentionally designed and maintained, public parks can serve as shared spaces for people of all backgrounds. Yet Garrett Dash Nelson, a curator at the Leventhal Map and Education Center at the Boston Public Library, points out that parks, in reality, "sometimes became mechanisms for maintaining systematized inequality." Such inequalities can be perceived on the ground, where park landscapes, much like roads and other public infrastructure, are often better maintained in communities with greater social privilege. When viewed through the layering of historic and present-day maps at the Leventhal, however, the complexity of the sometimes successful, sometimes fraught histories of parks becomes unmistakable.

On March 30, 2022, a cartographic exhibition exploring public parks, titled *More or Less in Common: Environment and Justice in the Human Landscape*, opens at the Boston Public Library. The exhibit includes work by Fredrick Law Olmsted, the landscape architect who would be turning two hundred this year. The opening coincides with the kick-off of the Olmsted Legacy Symposium, a three-day event that officially commences on March 31, primarily hosted at the Boston Society for Architecture. Gardens have been designed collaboratively with academic departments to showcase their research and teaching to visitors. The Pollinator GATEway Gardens, highlighting plants important for native bees, butterflies, hummingbirds, and other pollinators, were created with the nearby School of Veterinary Medicine. The project aligns with the school's research on the interconnections between the health of people, animals (both domestic and wild), and their environment.

Ricardo's leadership skills were tested when the pandemic forced our normally hands-on, outdoor internships into a virtual format. He demonstrated fast, adaptive leadership as he navigated his team through the initial unpredictable months of the pandemic. He found that it became even more essential to develop peer-mentor relationships, which encouraged his growth as a communicator. Ricardo says, "During the program, I was put in a position where leadership and innovation skills were needed to make things work in an environment that was unpredictable and always changing due to the pandemic." Similarly, Karyn credits the Learning by Leading program for shaping her into the collaborative leader she is today. When she started the internship, she told herself, "I need to work hard and figure everything out by myself." Then, as she progressed through the program and gained leadership experience, she realized that strength comes through working together.

Karyn also says that Learning by Leading helped her discover her twin passions for restoration and environmental education. She graduated in the spring of 2021 and immediately was hired by two local environmental organizations: the Putah Creek Council, where she organizes community volunteers to do creek restoration work, and the Solano Resource Conversation District, where she serves as an environmental educator. Karyn's growth as a leader and her impactful postgraduate jobs exemplify the power of reimagining the traditional university campus. All university campuses are more than lawns, sidewalks, and buildingsthey can be spaces where tomorrow's environmental change-makers learn to lead. #



Water Comes First

Robert A. Bartlett Jr. explains why a world-class collection of trees needs state-of-the-art irrigation.

M y decision to transform the R.A. Bartlett Research Laboratories and Arboretum into the living museum that exists today was centered on the need for water. My father, Robert Bartlett Sr., purchased the property in 1965, a few years after he became president of the family business, Bartlett Tree Experts. He intended for the 350-acre property, nestled in the rolling hills outside of Charlotte, North Carolina, to serve as a research laboratory and training center for the growing company.

To that end, the company established facilities and plots where staff scientists conducted experiments on plant care and pathology. Previously, this work had been performed in Stamford, Connecticut, where my grandfather had set up our first tree research laboratory and training facility in 1913. A portion of the original site still exists today as the Bartlett Arboretum and Gardens, although it has no affiliation with the company.

Robert A.

Bartlett Jr. is the chairman and chief executive officer of Bartlett Tree Experts. Previously, the Charlotte property had been a working horse farm with large fields and pastureland. When my father acquired the land, he planted azaleas (*Rhododendron*) and hollies (*Ilex*), along with other plants that form the basis of the collections we have today. In those early years, I remember seeing young trees begin to establish themselves and rise above the forage grasses.

The climate near Charlotte allowed the cultivation of species common in both northern and southern gardens, which was important since we had field offices throughout the United States (and now Canada, the United Kingdom, and Ireland). Still, the summers in Charlotte are hot and humid. To maintain the collections, we pumped water from one of three existing ponds to provide irrigation, but at first, the capabilities were technologically limited. The earliest systems consisted of gasoline-powered pumps sitting on the shore of the ponds and serving manually operated spigots. Remnants of those systems can still be found on the property, and portions of their piping are still in use today.

During the first thirty years in our Charlotte location, it was apparent that some of the plants were beginning to suffer from our limited irrigation capabilities. In particular, the collection of azaleas that my father had started planting on an eightyfoot hill, now affectionately called Rhodie Hill, required extensive watering. In midsummer, it was challenging to stay ahead of the heat, especially because the water had to be manually hauled up the paths that wind around the hill.

The impact of a changing climate also became more apparent at this time. When my father bought the land, the property was categorized by the US Department of Agriculture as being in plant hardiness zone 7 (meaning the average minimum temperatures fell between 0 and 10°F); however, it is now considered zone 8 (averaging between 10 and 20°F). Due to changes in the weather patterns, longer dry periods developed, and more dramatic swings in rainfall became the new normal. It was clear that we could no longer sustain our collections without investing in a state-ofthe-art irrigation system.

After my father passed away in 1998, we began to make a significant investment to help maintain and develop the property. It would continue to serve as a research station and laboratory, complete with a training facility for clients and arborists and a diagnostic clinic where our researchers process thousands of plant and soil samples sent by our field offices. At the same time, we were determined to continue building the collections into a world-class arboretum. With this goal in mind, we decided to put in an irrigation system that could provide consistent water to the growing collections.

We installed a new distribution system to feed the early network of pipes and facilitate manual watering capability in adjoining areas. Most importantly, the system directed a large volume of water to one of our ponds. Now, with the ability to keep a single, large reservoir of water full at all times, the Research Lab and Arboretum was primed for much more extensive, Today, the collections are expansive, consisting of over twentysix thousand accessioned plants. and automated, irrigation operations. In 1999, we began installation of the first automated system. It allowed us to direct a precise amount of water overnight to specific areas on the property. The collections grew like never before. The system also made new locations available for dedicated research plots. Automatic irrigation was a game changer.

At that point, we began to strategically build our collections. We launched collaborations with other arboreta and research institutions across the globe and started adding to the diversity of our cultivated plants. Today, the collections are expansive, consisting of over twenty-six thousand accessioned plants in fourteen major groups. We have one of the largest collections of holly in the United States, along with extensive collections of elm (Ulmus), crape myrtle (Lagerstroemia), maple (Acer), witch-hazel (Hamamelis), linden (Tilia), and boxwood (Buxus). Seven collections are accredited through the Plant Collections Network, including the largest collection of Magnolia cultivars in the world.

HISTORY OF HORTICULTURE Arbor Day Turns 150

"A few years since, some prophetic soul sounded a note of warning against the rapid destruction of our forests, and predicted dire consequences if the warning should go unheeded," the Chicago Tribune noted in 1872. "Measures have already been taken to counteract the effects of the carelessness of the past. The best plan seems to be that adopted by Nebraska. The State Board of Agriculture has set apart the 10th day of April as sacred to the planting of trees, and has baptized it as Arbor Day."



Arbor Day by Grant Wood, 1932. © Figge Art Museum, successors to the Estate of Nan Wood Graham/VAGA at ARS, NY

Among the collections, those which were established early and added on to over the years continue to be among the most satisfying for me to watch through the year. Our main grouping of magnolias borders Youngblood Road, a two-lane highway that passes the arboretum. When you drive around the corner and see the magnolias in bloom, the sight of the different colors almost takes your breath away. There is just about every shade and hue of purple, pink, white, and yellow that you can imagine. Rhodie Hill is another favorite. The hill comes alive in a kaleidoscope of spring color, and with mature specimen trees overhead, the winding paths offer beautiful surprises around every corner.

We have now begun focusing on wild-collected plant material, especially prioritizing species of conservation concern. One of the plants that we are playing a role in conserving is a rare North American species known as the pyramid magnolia (Magnolia fraseri var. pyramidata). In an effort to understand the distribution of this species and increase documented holdings in cultivation, our arboretum has partnered with The Morton Arboretum, the University of Florida North Research and Education Center, the Chicago Botanic Garden, the Atlanta Botanical Garden, and the US National Arboretum to scout populations, assess their health, and collect seed (when present) for propagation and distribution. Through collaborative efforts like this, and with other strong networking partners such as the Arnold Arboretum, Longwood Gardens, and many others, we have made conservation of rare species a new part of our mission.

Looking at all the natural beauty established here, visitors may find it easy to forget that this is a relatively young arboretum. We pride ourselves on the ability to adapt with the times and use our natural water resources to maintain the vitality and health of our collections. The key and catalyst to our success has been access to water and having the irrigation needed to help the plants thrive. Without it, we could not have created this botanical wonderland in such a short amount of time. *#*

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PLANT PORTRAIT

Metasequoia glyptostroboides

Hope Jahren on encountering a living fossil.

I fyou head north, far above the Arctic Circle, you will find yourself in a land of blue sky, white snow, and gray ice. There will be pockets, here and there—a lonely island, a sloping valley—that are dry, dusty, and desolate. Dig down, through a crust of lichens, take out the smooth stones underneath, and burrow into the shaley, ancient mud. When you get to layers no less than forty million years old, you will find conifer needles. Not only that, you will find twigs, branches, cones, and even whole trunks, dusted in ancient sap. I have seen this myself, during the odd, dream-like hours that are born of twenty-four-hour light.

Forty-five million years ago, at 79° north latitude, an immense conifer forest stretched in every direction, across what is now Canada, Alaska, and Siberia, quite close to today's North Pole. The idea of a forest so far north is nothing short of fantastic: today, the tallest plant in the region is a pussy willow—and a stunted specimen at that. The temperature and the rainfall above the Arctic Circle were certainly very different forty million years ago. Still, one thing has not changed: total light for three months, soon followed by three months of total darkness. No modern trees can tolerate these conditions, yet forests once thrived under this ridiculous annual regime. Foremost among the trees was *Metasequoia*. We recognize them from their needles—fossilized but so loose that they fall through your fingers like confetti.

Until 1948, most scientists assumed that *Metasequoia* was extinct, based on fossils from lower latitudes. That was the year the Arnold Arboretum received a package from Hu Xiansu, who trained at the Arboretum and returned to China with his doctorate in 1925. Hu sent bushels of seeds and other botanical materials, and he documented that they had come from—wait for it—live *Metasequoia glyptostroboides* growing in central China! Some of these seeds became the full-grown, magnificent "dawn redwoods" that now stand throughout the Arboretum (accessions 3-48 and 524-48).

Because of these seeds and the trees they became, I knew something about the fossils that we excavated in Canada that I would *never* have known otherwise: ancient *Metasequoia* trees were deciduous. Deciduousness is a special type of dormancy meant to decrease the stress of maintaining leaves through the winter. This trait, uncommon in conifers, would make all the difference as the trees prepared for the extended Arctic darkness. *#*

Hope Jahren's most recent book, The Story of More: How We Got to Climate Change and Where to Go from Here, was published in 2020.

Dawn redwood on Peters Hill. Photograph by Erik Berman





MODERN COLLECTIONS

The Third Fifty Years of the Arnold Arboretum

By Michael S. Dosmann

ound the bend on Hemlock Hill K Road and look across Bussey Brook and Kent Field to the north. Your eyes will skim a patchwork of conifer textures, colors, and forms. Among the trees is an upright individual with a rather abrupt taper at the top, the Arnold Arboretum's largest giant sequoia (Sequoiadendron giganteum, accession 1320-72*A), now standing eighty-three feet tall. After crossing the brook and walking up the slope, you'll see that the wide bole (almost five feet in diameter) begs to be hugged. Shift your gaze up along the orange bark to the sky, and you'll see the tree's candelabra-like branching pattern. Most of the branches seem normal, erupting out of the main stem at right angles,

This is the third installment in a series that opened with Charles Sprague Sargent's monumental "The First Fifty Years of the Arnold Arboretum." Richard Howard and Donald Wyman shared focused assessments at the Arnold's centennial.

Young and old plantings on Bussey Hill. Photograph by Alex S. MacLean



but if you step back and keep your eye on the crown, you'll see an odd conglomeration where one branch over another attempted to bend skyward.

Back in 1948 (the same year that Metasequoia glvptostroboides, the dawn redwood, arrived in North America), a supporter of the Arboretum, Chandler Hovey, collected giant sequoia seedlings from California and planted several near his home in Brookline, Massachusetts, a stone's throw from the Boston College campus. In 1972, in honor of the Arboretum's centennial, Boston College-which had recently acquired the Hovey property-donated the tree. That spring, a twenty-four-year-old, forty-two-foot-tall, pointy-topped tree was dug, transported, and transplanted in its current spot in the conifer collection. The magnificent specimen survived, but its central leader died due to transplant shock, leaving an ovalshaped form for decades. A new leader eventually took over: a dog-legged branch that formed fifty years ago from the initial crown's tip, some forty-three feet above the ground. I'm certain that the wooden rings within that branch would reveal not just what was going on with that single tree but the surrounding Arboretum landscape as well.



A forty-two-foot-tall giant sequoia moves to the Arnold in 1972. Photograph from Arnold Arboretum Archives

The First Fifty Years

Just as the sequoia's history is written within its rings, branches, and form, the Arboretum's landscape and collections reflect a history rich in dramatic events and subtle ripples. Much has been written about them, and Charles Sprague Sargent's "The First Fifty Years of the Arnold Arboretum" describes the first five decades with aplomb. At the time of Sargent's writing in 1922, Harvard's tree museum (founded in 1872) had expanded from 125 to 250 acres. Frederick Law Olmsted had reimagined Benjamin Bussey's farm with carriageways and pathways, collection areas and viewsheds. Sargent and his team transformed the landscape into a composite of taxonomic tree groups and research plantings, including an intensely cultivated shrub and vine collection, all nestled among a few natural and naturalized woodlands.

By 1922, botanical exploration—particularly of East Asia and North America—and horticultural exchange yielded a living collection of over five thousand taxa growing at the Arboretum. The institution was well on its way to meeting its initial charge (a nascent collections policy, if you will) to cultivate every tree, shrub, and vine hardy in Boston. While many of the plants were botanical taxa, including wild-origin species newly cultivated in North America, there was no shortage of infraspecific forms and varieties that we would now call cultivars. The herbarium of two hundred thousand sheets complemented a thirty-five-thousand-volume library and archival collection of nearly ten thousand photographs. With these integrated living, preserved, and archival collections, the Arnold Arboretum had become an international destination for scholars of woody plants.

Yet Harvard's tree museum was not just for the botanical connoisseur. This gem in Boston's Emerald Necklace of parks provided open space to an expanding and diversifying city. Because of the 1882 arrangement where ownership of the land shifted from Harvard to the City of Boston (who then leased the property back to the university for at least one thousand years), the space would be secured in perpetuity as both a scientific enterprise and public open space, free for all to enjoy. Without this arrangement some 140 years ago, I doubt if the Arnold Arboretum would exist today, or if it did, if we would recognize it in its current form. Had it remained a nonpublic, university-owned research station, I can imagine acres by the dozen being peeled away and sold with each-and-every



The space would be secured in perpetuity as both a scientific enterprise and public open space, free for all to enjoy.

economic crisis. If purely a municipal park, even if well maintained, it would not house one of Earth's most notable collections of woody plants. Luckily, these are just what-if scenarios.

Perhaps knowing his grip upon the Arboretum's helm would not last much longer (though it did, for another four years), Sargent ended his half-century assessment with a few bold charges for his successors. Global environmental change was apparent to him, particularly the challenges to trees and forests worldwide. Thus, Sargent called for continued and ambitious documentation of forests in Asia and the tropics, as well as rigorous scholarship in forest pathology, entomology, and genetics. Within the Arboretum landscape, Sargent felt that a rose and a rock garden would be essential additions, no doubt to provide space for new collections development while simultaneously enhancing the horticultural display. Despite the growth of the initial Arboretum endowment from \$103,847 to \$808,175, Sargent knew that additional resources would be required not just for these new initiatives but to maintain current operations. Thus, he curtly ended his fifty-year report with one sentence: "Only a larger endowment is needed to make possible these Arboretum activities and

extensions." Following his death in 1927, the Sargent Memorial Fund would raise over a million dollars.

The Second Fifty Years

The Arboretum's second half-century was dramatic and dynamic. The institution weathered a global economic depression, multiple leadership changes (one supervisor and three directors), the catastrophic hurricane of 1938, as well as another World War. There was also the Controversy (as it was referred to), which amalgamated the university's herbarium and botanical library collections (including most of the Arboretum's) under one roof in Cambridge. This coincided with the cessation of the Bussey Institution, which had opened as Harvard's center for horticultural and agricultural education in 1871, on property adjacent to the Arboretum. The institute grew into a center for genetic and cellular research. By the 1930s, most of the on-site scholarship in the Arboretum's living collections had waned. Likewise, the Arboretum's fieldwork in temperate areas, particularly to acquire germplasm to grow in the living collections, ceased almost entirely. However, botanical exchange of seeds persisted, with the 1948 acquisition of the Chinese dawn redwood,

Metasequoia glyptostroboides, being one of the most celebrated feats even to this day.

The discipline of horticulture—often considered the art and the science of growing plants—matured in the mid-twentieth century. The genetic improvement of ornamentals hit a stride, as did advanced ways to propagate them clonally. As a result, cultivars (first given formal recognition in 1952) wantonly tumbled out of nursery catalogues and into gardens, parks, and other managed landscapes. The Arboretum's living collection was no exception.

In 1970, Donald Wyman, horticulturist in charge of the Arboretum from 1935 to 1970, wrote in these pages about the Arboretum's goal to improve the curation and care of the collections, and to use the collections as a living laboratory for horticultural introductions. Species plucked from the wilds in the Arboretum's first half-century would be assessed for their garden worthiness in the second. Novel hybrids, like crabapples (*Malus*) and forsythia (*Forsythia*) created by Karl Sax (a professor who then served as director from 1947 to 1954), were given growing space, with many introduced as cultivars after evaluation. Arboretum selections, and those from sister institutions and industry, were grown side-by-side, their performance recorded in *Arnoldia* and other publications.

Just like there were changes to what the Arboretum grew in the collections and why, there were changes to where they were grown. The 1942 acquisition of the Case Estates in Weston, Massachusetts, provided a welcome relief valve for the spacecramped Boston collection. Shortly thereafter, several ornamental collections in Boston underwent redesigns: Landscape architect Beatrix Farrand's Azalea Border along Meadow Road added dramatic color and space for the deciduous Rhododendron that were performing poorly elsewhere. Crabapples, the dandy of mid- to late-twentieth-century landscapes, replaced most of the hawthorns (Crataegus) on Peters Hill during renovations from 1948 to 1952. The construction of the Dana Greenhouses in 1962 provided a sophisticated station where propagator Alfred Fordham could conduct his many experiments and publish them widely.

Collections of the Third Fifty Years

The centennial in 1972 arrived with fanfare and excitement. Dick Howard, director since 1954, began his 1971 annual report to the Harvard University Provost by underscoring the Arnold Arboretum's essential service role to the City of Boston, particularly to local communities. Maintaining the Arboretum required considerable resources that were worth the expense and investment, and caring for the collections was his "priority responsibility." Thus, irrigation projects in both Boston and Weston would alleviate some of the growing and unmet demands for water. A bucket truck was added to the fleet, which made pruning or removing old, senescing "stag-headed" trees easier. To replace some of the removals, horticulturists planted out nearly nine hundred specimens, completing a cycle of rejuvenation and renewal. Anticipating future databasing, Howard noted that the plant records office had wrapped up a major inventory campaign to assess and field-check every specimen in the collection.

Over the Arboretum's third fifty years, the institution would be led by four directors: Richard Howard's tenure ended in 1978; Peter Ashton led from 1978 to 1987; Robert Cook from 1989 to 2009; and William (Ned) Friedman became director in 2011. During this time, the Arboretum experienced dramatic changes, as did the living collections. Staff actively contemplated what to cultivate, where to grow it, and how to do it better.

Major anniversaries like a centennial can elicit reflections and ambitions, so it is no surprise that shortly after Peter Ashton became the director in 1978, strategic planning was underway. One broad initiative, a restoration plan, included a substantial section for what should be in the collections. A formal living collections policy-the first for this Arboretum and most botanic gardens-was also published in 1979, remaining in force for almost thirty years. In this latter document, the Arboretum established and codified ambitious goals: to acquire all known woody species hardy in Boston (no different from the original charge of 1872); to have three individuals of each species; to prioritize wild-provenance plants above those of garden or nursery origin; and (assuming they met specific requirements) to continue to maintain taxa at infraspecific ranks (including cultivars, although these were considered lowest in any hierarchy).

To complete the collections, the 1979 restoration plan outlined the addition of over 2,900 taxa, spanning 90 families and 363 genera. These desiderata came almost exclusively from identifying which plants in the 1940 edition of Alfred Rehder's *Manual* of *Cultivated Trees and Shrubs Hardy in North America* were missing from the collection. To launch the initiative, staff set an ambitious goal of acquiring 1,500 taxa in the first five years.

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The layered naturalism of the Arnold Arboretum arises from generations of horticultural stewardship and curation. *Photograph by Jonathan Damery*

Even before strategic planning of *what* to add, the Arboretum reconsidered *where* new material would come from and *how* to acquire it: collectors would return to the field. In 1977, the Arboretum embarked on its first major collecting trip in some forty years, sending taxonomists Stephen Spongberg and Richard Weaver to South Korea and Japan for six weeks. In 1980, following the heels of the restoration plan, Weaver botanized in the Soviet Union, while Spongberg participated in the three-month-long Sino-American Botanical Expedition, which involved a team of thirteen Chinese and American collaborators. (China had not been visited by Western botanists since before the revolution in 1949.) The era of fieldwork had returned.

Through the 1980s and early 1990s, the infusion of wild-collected material from some seventeen expeditions occurred at a scale not seen in fifty years. In some years, the Arboretum sponsored multiple collecting trips. Destinations included those known to yield hardy material such as northwestern Hubei Province, China, and the Appalachian Mountains of the American Southeast, as well as fringe regions like North Africa, Mexico, and Taiwan. Coincident with fieldwork, the Arboretum also received new material from sister institutions, often selected from their annual seed lists (known as *index semina*).

Although the restoration plan advised against "returning to what must have been almost a jungle by the end of Sargent's tenure as Director," there was no discussion as to where some five thousand new plants (an increase by approximately 30 percent) would be sited in the collections. Thus, limitations in capacity and resources-facilities, staffing, and space-hindered the restoration's full success. For one, the Arboretum lacked the facilities to propagate and produce the sheer magnitude of material arriving in such a short period. The plant records database is replete with notations from index cards of whole flats of accessions that perished due to the lack of production space (many were placed in the shade below the benches). Gary Koller, Wyman's successor as the lead horticulturist, has told me how, due to severe space constraints in the collection in the 1980s, sibling plants of the same accession were planted together in tight triads, about five feet apart. Only a few of the

Through the 1980s and early 1990s, the infusion of wild-collected material from some seventeen expeditions occurred at a scale not seen in fifty years.



Hao Riming of the Nanjing Botanical Garden (left) and Peter Del Tredici were among the team on a 1994 expedition to Hubei, China. *Photograph by Paul Meyer, Arnold Arboretum Archives*



Hiroshima University's Katsuhiko Kondo (top, left) assisted Stephen Spongberg and Richard Weaver in Hokkaido, Japan, in 1977; David Boufford photographed members of the 1984 Sino-American Botanical Expedition to Yunnan, China, as they prepared to embark into the field. *Photographs from Arnold Arboretum Archives*

triads remain today, primarily sited along the roads and perimeter of Bussey Hill. Deaccessioning plants was taboo, so there were few other alternatives. The 1979 restoration document was successful as an acquisitions plan yet perhaps too ambitious given practical considerations.

A decade later, following changes in Arboretum leadership (Robert Cook became director in 1989), a Living Collections Long-Range Planning Committee returned to the process of thinking about the collections. In 1991, the committee completed a planning document, edited by Stephen Spongberg, which acknowledged that the 1979 restoration may have been naïve. The committee noted the challenges in adopting a comprehensive collection (meaning one of every taxon) versus a synoptic or broadly representative collection. They observed that it would be difficult to preserve the integrity of the Arboretum's historic landscape in light of the aggressive drive to acquire new material. Nevertheless, the plan ended with a reaffirmation of the same ambitious collection policy goals articulated in 1979.

To accommodate this expansion while remaining sensitive to the Olmsted design (by not transforming the collections into a dense forestry plantation), the 1991 plan called for the prudent review and deaccessioning of low-value and out-of-sequence material. The authors proposed a long-term review process that would finally deal with many of the growing pains that had affected the Arboretum since (and perhaps prior to) the death of Sargent. Although there were no estimates of how many plants could be deaccessioned, the authors stated that such subtractions would be insufficient to accommodate the necessary expansion. The 1991 plan estimated that all Arboretum property must be designated for the purpose of housing an expanded collection, including the entirety of Peters Hill, Bussey Brook Meadow (formerly called the South Street Tract or Stony Brook Marsh), Weld Hill (formerly Weld-Walter Street Tract), and the Case Estates. Space was not the only resource required: the plan identified new staff positions necessary for curation, horticulture, and the greenhouse and nursery.

Shortly after the 1991 plan was completed, it was put on hold following a reorganization of the Arboretum's administrative structure in early 1992. A new Living Collections Department was created, with Peter Del Tredici leading. The ambitious goal of the 1979 and 1991 plans to form a comprehensive collection was admittedly unrealistic and abandoned.

Instead, as Del Tredici outlined in 1994, collections development would take a more focused or prioritized approach. During the early 1990s through the mid-2000s, special recognition was reserved for conservation-status species (particularly those maintained in collaboration with the Center for Plant Conservation). As a theme, the floras of eastern Asia and eastern North America were given priority, particularly genera like Acer (maples) and Fagus (beeches), which became two of the initial five collections nationally accredited through the Plant Collections Network. (The Arboretum now has eight accredited collections.) The recently established North America-China Plant Exploration Consortium (NACPEC) became a pipeline for novel germplasm from China. From 1991 to 2006, the Arboretum mounted six expeditions to China, two under the NACPEC flag, including the 1994 expedition to Hubei that infused the collections with new material like the paperbark maple (Acer griseum), which had most recently been collected by Ernest Henry Wilson in 1907.

Within a year of joining the staff in 2007, I organized a team to update collections goals and codify them in a new living collections policy. The scope of the collections would remain synoptic, with the highest priority assigned to core collections, such as the nationally accredited collections and conservation-status holdings. Historic lineages would be maintained through repropagation, while targeted acquisitions of cultivars would meet trialing, display, and research needs. The new policy (and its subtle revisions over the past fifteen years) prompted the review and subsequent deaccessioning of excessive or low-value accessions, as well as the repropagation of valuable lineages that had gone unnoticed.

Fieldwork continued, with another six expeditions occurring between 2007 and 2015, including a NACPEC expedition to the Qinling Mountains of China in 2010 and a more focused collecting of live oak (*Quercus virginiana*) from the northeastern edge of its range in Virginia in 2012. In 2015, the Arboretum launched the Campaign for the Living Collections, an initiative that followed several years of planning from the Living Collections Advisory Board. The campaign articulated a list of nearly four hundred target taxa, each linked to one or more priority themes found in the collections policy. Since the campaign launched, some twenty expeditions—to destinations in the United States, China, Japan, and the country of Georgia—have yielded over half of the desiderata. The COVID-19 pandemic paused expeditionary work for 2020 and 2021.

While the Arboretum embarked on exactly fifty named expeditions over the past fifty years, plants of cultivated origin were added to the collections (or maintained) for their invaluable ornamental characteristics, stress tolerance, and other novel traits valued in managed landscapes. Cultivars of trees continued to grow alongside their wild-origin brethren-particularly in the Rosaceous orchards of Peters Hill—while new shrub cultivars appeared in the Bradley Rosaceous Collection (dedicated in 1985), the Leventritt Shrub and Vine Garden (dedicated in 2002), and other landscapes. In 1972, 14,058 plants grew in the Arboretum's collections in Boston, and only 14 percent were of wild origin. As of this writing, 44 percent of the 15,939 plants in the collections were derived from wild populations, and if one excludes over 2,700 accessioned plants in the natural areas (such as Hemlock Hill, which is a mix of wild and planted hemlocks), 53 percent of the collections are from the wild. That is quite the illustration of focused and deliberate collections development.

Designing the Collections

Perhaps the most significant outcome from the 1979 restoration plan was the recognition of historical planting areas, as articulated loosely using the Bentham and Hooker linear sequence. Richard Weaver created maps for each family and major genus, using red colored pencil to illustrate where new plantings should go (or, in some cases, errant shrubs should be returned). This reordering was meant to fix what were perceived as random horticultural plantings, particularly those from the mid-twentieth century.

All gardens need redefinition from time to time, and many areas within the Arboretum received edits over the past fifty years. For instance, Rhodie Dell the collection of broadleaved *Rhododendron* along Bussey Brook at the base of Hemlock Hill—was renovated in 1990 with the Davison Path laid out by Julie Moir Messervy. The landscape around the Hunnewell Visitor Center received a new look by Carol Johnson after the building was renovated in 1993. In 2007, Beatrix Farrand's Azalea Border along Meadow Road received an infusion of new material following the removal of declining individuals.

One of the major goals Sargent described in 1922 was the creation of a rose garden, and in 1985



James Papargiris

Forty-Plus Years at the Arnold Arboretum

t's no surprise that the Arnold Arboretum, an institution committed to growing and studying long-lived woody plants, has inspired long tenures among staff. Charles Sprague Sargent, the Arboretum's first director, claims the title of the longest-serving employee, with a tenure just shy of fifty-five years. The dendrologist John George Jack was the next longest, at forty-nine years. Three others during the first century had tenures lasting more than forty years: the taxonomist Alfred Rehder, propagator Jackson Thornton Dawson, and assistant horticulturist Heman Howard.

During the most recent half century, several others have joined the ranks of those who have invested more than forty years: propagator John (Jack) Alexander III, librarian and archivist Sheila Connor, superintendent of buildings and grounds Henry Goddell, horticulturists Dennis Harris and Mark Walkama, and greenhouse horticulturist Bob Famiglietti.

At present, James Papargiris reigns as the longest-serving current employee. Papargiris joined the staff in 1979, the year the Arboretum instituted a new collections policy. He now serves as the Arboretum working foreperson.



The Leventritt Shrub and Vine Garden is one of two showcase gardens built during the Arnold's third fifty years. *Photograph by Jon Hetman*

the Arboretum made good on this promise. A gift by Eleanor Cabot Bradley and an innovative design by Gary Koller created the Bradley Rosaceous Collection. Located near the ponds and replacing the existing shrub collection (where many of the Rosaceous shrubs grew already), this semi-formal garden adjacent the Forest Hills Gate became and continues to be a public gathering space and programming site. Updates completed in 2011 (by Julie Moir Messervy) improved circulation and display potential, and two wrought-iron arbors designed by Peter Andruchow added spaces for climbing roses.

While the Bradley created a significant destination for visitors, the diaspora of shrubs and vines from the earlier shrub garden led to a problem. Many of the vines were moved to chain-link fences on the perimeter, becoming challenges to maintain, while sun-requiring shrubs—now grown in the shade under their arboreal cousins—did not always fare well. To ameliorate this dilemma, the Arboretum needed a new shrub and vine collection, and with a gift from Frances Leventritt, the Victor M. and Frances Leventritt Shrub and Vine Garden was created in 2002. Designed by Reed Hilderbrand, this formal garden would house sun-loving shrubs and vines on property to the north of the Dana Greenhouses, on space previously occupied by the old hedge and dwarf conifer collection. Unlike other areas of the Arboretum's collections, the shrubs and vines grown here were to receive intense horticultural care and inspire ideas for home landscapes.

Peters Hill, often neglected due to a lack of resources and its distance from the hub of operations, began to receive attention starting with a curatorial review in 1993. Low-value plants were deaccessioned; new plantings (particularly crabapples and deciduous gymnosperms) followed; and a bus turnaround at the summit was removed and renovated to support plant collections in 1997. Another major change occurred in 1996 when the South Street Tract was combined with land owned by the Massachusetts Bay Transportation Authority and the City of Boston, creating what is now known as the Bussey Brook Meadow, a twenty-six-acre urban wild with the Blackwell Path connecting Forest Hills Station to the South Street Gate. All gardens need redefinition from time to time, and many areas within the Arboretum received edits over the past fifty years.

Stewarding the Collections

In his 1971 report, Richard Howard noted that his highest priority was the maintenance of the living collections. His successors possessed the same agenda, mustering resources to support them as creativity and windfall allowed. Over time, work at the Case Estates waned to the point that by 1991 the horticultural staff in Weston shifted permanently to care for the collections in Boston. (The final sale of the Case Estates occurred in 2017.) Ongoing growth in the Arboretum's endowment, particularly during the capital campaign ending in 2000, allowed further staffing increases, and restricted endowments for areas like the Bradley Rosaceous Collection and the Leventritt Shrub and Vine Garden funded exclusive and dedicated horticulturists to care for each high-maintenance area.

Another major shift in resourcing occurred with the launch of the Landscape Management Plan in 2008, a charge led by Richard Schulhof (the deputy director) and implemented by Stephen Schneider (then the manager of horticulture). Recognizing the value of having already designated horticulturists in several areas, such as the Shrub and Vine Garden, the Landscape Management Plan expanded the perspective to all areas of the Arboretum landscape. The landscape was divided into zones, with individual horticulturists assigned to steward each according to goals specific to each area. The plan also directed the work of arborists as they rotated through the collections, and landscape staff as they maintained meadows, turf, and pathways.

In addition to performing the day-to-day care of the collections, horticulturists must contend with periodic natural disasters, pests, and diseases. Though not as cataclysmic as that infamous and unnamed hurricane that struck in 1938 (which destroyed some fifteen hundred trees), the 1997 April Fool's Day storm dumped over two and a half feet of snow on a collection previously plagued by past droughts. Over four hundred trees had to be removed that season, while another thirteen hundred remained but required arboricultural care. Pathogens and pests are a persistent threat to the collections. For instance, in the 1980s and 1990s, phytoplasmas plagued the lilac (Syringa) collection, and in 1997, hemlock woolly adelgid arrived at the Arboretum's doorstep to forever change the face of Hemlock Hill, a unique natural landscape where black birch (Betula lenta) are slowly replacing the hemlocks (Tsuga). And, in 2018, many old beeches (Fagus) were removed due to decline caused by the arrival of beech bark disease. All three of these collections-the lilacs, hemlocks, and beechesare nationally accredited, so their stewardship in response to these outbreaks is especially significant. The Landscape Management Plan includes response plans for disaster and plant healthcare issues like these.

In late 2019, Andrew Gapinski, as manager of horticulture, transformed the third edition of the Landscape Management Plan into a dynamic, digital format known as the Landscape Management System. As part of the system, a smartphone and desktop application called ArbManager replaced the paper forms (the "green cards") exchanged between horticultural and curatorial staff to communicate about work requests, while an internal website, ArbDashboard, synthesized horticultural and plant records data into a map-based system. Both of these tools provide living collections staff instant access to collections-care directives, whether they are in an office or fifty feet up a tree and accessing the information from a phone.

Recording the Collections

The Arboretum is replete with uniquely accessioned plants, each richly documented with source histories, observations, photographs, herbarium specimens, and maps-a tradition dating back to the institution's founding. In Howard's 1972 annual report, he noted how the card catalog entries-the original paper database for the living collections, if you will-were incorporated into the Plant Records Center of the American Horticultural Society. This initial digitization effort was championed by Howard when he was president of the American Association of Botanical Gardens and Arboreta. The shared database gave gardens the chance to store computerized records off-site (as a preservation initiative) and recall specialized lists of plants on demand (for instance, all plants in a given location within a garden).

In 1985, the Arboretum's plant records and systems (including definitions, workflows, and philosophies) seeded a new database eventually called BG-BASE. The Arboretum now had local access to its data, which revolutionized how the Arboretum and finally other gardens curated their collections. At first, the database only included living plants; however, funding from the Institute of Museum and Library Services (IMLS) in 2010 allowed staff to integrate legacy data from old index cards into BG-BASE, providing access to historic collections that had long ago perished. An earlier IMLS grant, in 2001, enabled the digitization of records for some fifty thousand vouchers from the herbarium of cultivated plants, adding even more data and research value to plants that grow or grew in the living collections.

Hand-drawn maps had recorded the locations of plants growing in the collections since 1938, and in 1987, cartography went digital due to support from IMLS. Initially, AutoCAD served as the digital platform; however, in 2010, the platform shifted into ESRI ArcGIS, a more robust geographic information system. This change was timely, as the IMLS grant in 2010 also allowed for the scanning and georeferencing of some two thousand hand-drawn maps, providing staff the ability to view-like a digital flip-bookthe historic collections over time. Coincident with the legacy of mapping has been the annual inventory process, whereby all accessioned plants are fieldchecked on a five-year cycle. Whereas earlier field observations required paper cards, notebooks, and copies of maps, the current team led by Kyle Port, the manager of plant records, employs live connections to the database in the field using laptops and tablet computers. I wonder what Professor Sargent would think if he could witness such activities in action!

While countless other initiatives over the past fifty years led to curatorial reviews and data acquisition, one final, and significant, venture was a multiyear verification project funded by the National Science Foundation in 1984. This project led to the vouchering (using herbarium specimens) of the living collections. The vouchers were then distributed to taxonomic specialists around the world who verified the identity of each plant. The effort yielded positive (as well as negative) identifications and fostered international research interest in the living collections.

Using the Collections

While this article mostly reflects the living collections and their change over time, to leave out access and use would be a grave mistake. The Arboretum is not a private collection but is, in fact, very public. Due to the porous nature of the Arboretum, visitor counts have always been a rough guess. Until recently, estimates of annual visitors were in the "hundreds of thousands," which at the time may have been accurate. However, a people counter at the popular Arborway Gate-one of more than a dozen entrances-tallied some 825,000 hits from September 2020 to September 2021. This number includes ins-and-outs as well as pass-throughs, yet even with a conservative estimate of half this total (equal in and out hits) of 400,000 visitors at this single gate, it is safe to assume that well over a million people, and perhaps over twice that number, visit the Arboretum each year.

After the Bussey Institution ceased to exist and much of the herbarium and library migrated to Cambridge, it had become more difficult for the living collections to readily serve scholars. However, engaging scholars to use the living collections has long been an area of interest of mine, even before joining the staff, and was one of the reasons I was hired into this role fifteen years ago. Luckily, much work had been initiated before my arrival. Five decades of field exploration yielded a collection rich in botanical diversity and wild provenance: research specimens little different from what a scholar could find in the natural environment. Year-over-year improvements in horticultural care provided healthier plants available for study. Ongoing vouchering, verification, and inventory initiatives add rich documentation to the plant records, all of which have been searchable online for over two decades.



Meadow Road, a winding Arnold thoroughfare, welcomes at least half a million visitors each year. *Photograph by Jonathan Damery*

Funding also helped bring scholars to the collections. In 1988, initial support (and later an endowment) provided by George and Nancy Putnam created the Putnam Fellowship specifically for those conducting independent research and project work using the collections. These and other competitive awards have helped to remove financial barriers that might otherwise prevent research from occurring.

Lastly, in 2011, the Weld Hill research facility opened. While it was initiated and built during the administration of Bob Cook and opened and staffed shortly after Ned Friedman became director, the facility was inspired by Peter Ashton, who attempted to reinstall scholarship within the Arboretum landscape during his tenure. Now, after some seventy-five years since the Bussey Institution closed, research and its requisite facilities are unified with the Arboretum's living collections. As a result, visiting scholars from all over the world can work in state-of-the-art laboratories just footsteps from the living collections. Shortly after I began my work at the Arboretum, about a dozen projects occurred in the collections each year. Currently, some seventy-five to one hundred projects use the living collections, landscapes, and environments annually.

The Fourth Fifty Years

The year 2072 seems so far off. I doubt that I'll be above ground, or if I am, how well I will be able to peruse the collections as they celebrate their bicentennial. Still, if I am around at that time, just a few years shy of my own centennial year, I would like to see the trees from the 1977 expedition to Korea and Japan spreading their branches among the overstory of the collection. I would like to see plants from the Campaign for the Living Collections: some of those trees have recently been released from the nursery and are already taller than me. I'm confident that many will have become standouts—the masterpieces of a new generation—and subjects of research that we would find impossible to imagine in 2022.

And of course, I would also make my way over to the giant sequoia that overlooks Bussey Brook, checking in to see how it had fared. No doubt, it will have weathered droughts and blizzards, perhaps even a lightning strike due to its ever-increasing height. But I like to imagine it will still be standing, a silent sentry watching over Harvard's tree museum. ##

MICHAEL S. DOSMANN is the keeper of the living collections at the Arnold Arboretum.



RARE AND ENDANGERED

Saving the World's Threatened Trees

By Silvia Alvarez-Clare, Kirsty Shaw, and Sarah Pocock



iking through the hot, dry canyons at the base of the Sierra La Laguna peaks in Baja California Sur, Mexico, it is impossible to miss the beautiful arroyo oaks (Quercus brandegeei). The trees border the banks of the seasonal streams (or arroyos) like kneeling giants washing their limbs in the refreshing water. What is less obvious is that these represent a relict species that can only be found here, along the riparian zones of the Sierra La Laguna Biosphere Reserve, a biodiversity hotspot with high levels of endemism and great beauty. Each November, the tree canopies fill with elongated acorns that cause a lively commotion as birds, beetles, and rodents frantically eat the fruit on the trees and underneath. Ranchers value the trees too, frequently building corrals under their merciful shade and collecting acorns to feed livestock. However, populations of the arroyo oak are declining. There is no evident seedling regeneration, and the remaining trees are all more than one hundred years old. Until recently, the cause for decline was mostly unknown.

Reserachers use fenced exclosures to study seedling regeneration beneath endangered arroyo oaks (Quercus brandegeei) in Baja California Sur. Photograph by Silvia Alvarez-Clare

Across the globe from the Sierra La Laguna, Mount Mulanje-known as the "island in the sky"-rises from the plains of southeastern Malawi with such sheer contrast that it creates its own climate and flora. Best known and most impressive of the forest trees is the cedar that takes its name from these mountains. The Mulanje cedar (Widdringtonia whytei) is highly valued for its durable and fragrant timber, but due to overexploitation and illegal logging, the cedar has reached the point of near extinction. A similar fate is faced by a rare magnolia (Magnolia grandis) found only in the forested limestone mountains of southern China and northern Vietnam. With its large, leathery leaves growing to over a foot in length, this magnolia coexists in tiny forest fragments with other critically endangered species, including the strikingly unique Tonkin snub-nosed monkey. Recruitment of new seedlings is impaired by local agricultural practices in which farmers clear vegetation before planting cardamom and repeatedly weed out the magnolia to maintain their crop. Fewer than three hundred adult trees remain in small, isolated populations.

The loss of trees is a global problem. Evidence of declining populations, illegal logging, lack of regeneration, and new pests and diseases has been looming over our heads for decades. Until last fall, however, the complete picture of the status of the planet's tree diversity was unknown. The *State of the World's Trees*, published in September 2021, shares the results of the Global Tree Assessment—the first conservation audit of most of the world's nearly sixty thousand species. The results show that 30 percent of all tree species—more than 17,500 species—are threatened with extinction. That's more than double the total combined number of globally threatened mammals, birds, reptiles, and amphibians.

The Global Tree Assessment also reveals that at least 142 tree species are recorded as extinct. Losing even a single species can have severe consequences for an ecosystem. As primary producers at the base of the food chain, plants, including trees, are the building blocks of ecosystems-essential to all life on this planet. Myriad species of plants, animals, and fungi are intrinsically linked to trees, often interacting within complex and fascinating relationships that both parties depend on for survival. In addition, individual tree species play numerous economic, ecological, and cultural roles. We depend on trees in our everyday lives-they provide us with food, timber, and medicine. According to the assessment, at least one in five tree species has a recorded human use, and many have a variety of different uses. While the challenges and scale of the problem in maintaining tree species diversity are significant, we can do something about it.

A Global Campaign

The *State of the World's Trees* is a sobering reminder that trees need our help. The Global Trees Campaign is coled by Botanic Gardens Conservation

Top Threats to the World's Trees

Percentage of trees affected

29%	Agriculture	(crops)
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- 27% Logging
- **14**% Livestock farming
- 13% Residential and commercial development
- 13% Fire and fire suppression
 - 9% Energy production and mining
 - 6% Wood and pulp plantations
 - 5% Invasive and other problematic species
 - 4% Climate change

"Over the past three hundred years, global forest area has decreased by about 40% and 29 countries have lost more than 90% of their forest cover."

SOURCE: BGCI. 2021. State of the World's Trees. BGCI: Richmond, UK. International (BGCI) and Fauna & Flora International (FFI). Through this effort, researchers, conservationists, and on-the-ground partners have been working together since 1999 to reduce threats and secure or recover target populations of threatened tree species through *in situ* action. Since its establishment, the campaign has worked to conserve over four hundred threatened tree species in more than fifty countries, and the team has trained more than ten thousand people in tree conservation skills.

Botanic gardens and arboreta have been vital partners in this effort. Since 2017, for example, The Morton Arboretum, near Chicago, has led a Global Trees Campaign project that aims to safeguard the arroyo oak (Quercus brandegeei) of Baja California Sur. Researchers collected genetic, phenological, and ecological data on this endangered species to explore the causes of decline and identify conservation and management actions needed to save it from extinction. The team established fenced exclosures to quantify the effect of grazing and trampling by free-roaming livestock on seedling survival and growth. They found that cattle and goats eat the seedlings while pigs eat the acorns—a combination that prevents any natural regeneration from occurring. To combat these threats, Mexican scientists, land managers, ranchers, and international experts are working together to implement a management plan for this species. Among their actions, the team has conducted plantings

within fenced areas to boost population recovery; they have encouraged ranchers to adopt oak seedlings and plant them within their fenced gardens; and they have worked with land managers to establish larger grazing-free zones within the reserve.

As illustrated by the work safeguarding the arroyo oak, effective conservation should be informed by accurate baseline information, including a thorough understanding of the species biology, specific threats, and potential actions to mitigate and reverse the decline. Scientific research is one of the cornerstones of the Global Trees Campaign. Once the baseline information is gathered, tree conservationists must develop a plan to improve the success of the interventions. The planning can prioritize individual species, like the arroyo oak or the Mulanje cedar, or larger groups of tree species present in the same area or experiencing similar threats.

In Kenya, for instance, Global Trees Campaign partners collaborated with the Kenya Forest Service and the Conservation Planning Specialist Group (part of the International Union for Conservation of Nature) to organize a series of online workshops focused on planning conservation action for Kenya's threatened trees. The workshops brought together key stakeholders to evaluate the results of an analysis for Kenya's more than 140 threatened tree species. This effort helped prioritize sites for conservation by grouping threatened species that are likely



to benefit from the same conservation activities. During these workshops, the participants developed a joint vision statement and goals, and they identified actions at national and regional levels. The Global Trees Campaign plans to continue using this larger-scale approach in the future, maximizing efforts and often achieving more cost-effective results than approaches focused on individual species.

Comprehensive Information

Before the State of the World's Trees was published, comprehensive information was lacking on which tree species are threatened with extinction and where conservation efforts should be directed. Some assessments were available on the International Union for Conservation of Nature's Red List of Threatened Species and national Red List publications. Still, the information was not easily accessible, and the scale of the problem was unknown. To produce a global overview of the conservation status of trees, the Global Trees Assessment team collated existing assessments, and each species was assigned one of six risk categories: extinct, threatened, possibly threatened, not threatened, data deficient, and not evaluated. Although this effort alone was an enormous task that took more than five years and five hundred contributors, it also revealed the information gaps regarding many tree species. In the report, well over seven thousand species were classified as data deficient, meaning there wasn't enough information for an assessment. Moreover, assessments for many little-known tree species are often based on historic herbarium records that may misrepresent recent changes in land use or loss of populations. Further survey work is therefore required.

The information from the Global Tree Assessment can be accessed online via a public web platform, the GlobalTree Portal. The portal highlights the scale of the problem and provides information on the numbers of species found in at least one protected area (as well as species not represented in any protected areas). The portal also shows which species are present in, or absent from, ex situ collections, such as botanical gardens and seed banks. According to the GlobalTree Portal, approximately 56 percent of threatened tree species occur in at least one protected area, and 21 percent are maintained in botanic gardens or seed banks. Another online tool, Conservation Tracker, provides real-time information on who is taking conservation action for which species. These tools will be updated regularly, helping to guide ongoing conservation efforts. The idea is that





Top row: Sustainable resin-tapping methods have been developed for lansan tree (*Protium attenuatum*) in Saint Lucia; Researchers prepare for a seed collecting trip in Brazil; Hand pollination of an endangered fir (*Abies ziyuanensis*) in China. *Photographs by Jenny Daltry, FFI; Noelia Alvarez Román, BGCI; Ding Tao, Guangxi Institute of Botany*









Bottom row: A researcher measures the diameter of a tochwood species (*Canarium* sp.) in Indonesia, the country with the third-highest number of tree species in the world; In Bhutan's Dangchu Valley, seedlings of tsenden (*Cupressus cashmeriana*), a species threatened by unsustainable logging, are readied for planting. *Photographs by Yanuar Ishaq, Dc/FFI; BGCI* on-the-ground efforts, such as Global Tree Campaign projects, will use this information and contribute new data as they evolve, creating an information feedback loop that will result in effective conservation actions.

Targeted Action

According to the Global Tree Assessment report, agriculture and logging are the leading threats to trees globally. When managed effectively, protected areas can provide vital protection against this kind of habitat loss, but in some cases, ecological constraints and threats within protected areas can still prevent or limit regeneration. For instance, even though the arroyo oak occurs within the Sierra La Laguna Biosphere Reserve, natural regeneration has been impossible due to grazing. Tree conservationists must therefore identify and remove barriers to natural regeneration, although additional interventions may be necessary for many species, such as those with extremely small populations. In such cases, planting can be an essential strategy to increase population numbers or reintroduce a species.

In the case of Magnolia grandis, with a global population totaling fewer than three hundred adult trees, targeted action was needed to ensure the future of the species. Since 2013, as part of the Global Trees Campaign, FFI has developed an outreach program with local cardamom growers at Tung Vai Watershed Protection Area in Vietnam. These efforts are paying off, with local cardamom farmers now willingly maintaining M. grandis seedlings, indicating a shift in attitudes and behavior towards this species. Over the same period, regular community monitoring and patrolling to protect trees from logging was introduced, resulting in no felling or damage to M. grandis individuals at Tung Vai since 2017. In addition, local communities have adopted fuel-efficient stoves, reducing pressure for firewood. Given the low number of individual trees in the original populations, tree conservationists are conducting booster plantings using nursery-grown seedlings. Natural regeneration of M. grandis is now occurring in other areas of the forest where previously there was none, indicating that recovery work over the last eight years has been successful.

For the Mulanje cedar (*Widdringtonia whytei*) from Malawi, illegal logging was so intense that it removed the natural seed source from the mountain, and increased man-made fires impeded recruitment of remaining seedlings and young trees. As part of a campaign project led by Mulanje Mountain Conservation Trust, the Forestry Research Institute of Malawi, and BGCI, staff set up eight community nurseries around Mount Mulanje with more than eighty community members who had been taught to propagate the Mulanje cedar. Over four hundred thousand seedlings were purchased from community nurseries and planted by local people, providing employment opportunities and vital income. Restoration experts from the Ecological Restoration Alliance of Botanic Gardens are also helping to improve planting practices so that more trees survive and grow better. An extensive network of firebreaks is maintained on the mountain to protect planted seedlings.

Furthermore, international trade of the Mulanie cedar was restricted when the Convention on International Trade in Endangered Species of Wild Fauna and Flora (a multinational agreement often known as CITES) included the cedar on its list of species that are potentially threatened with extinction. Alternative sustainable uses of cedar are being investigated that could provide additional benefits to local people. Essential oils can be produced from the tree's wood and leaves, and researchers have investigated the components of this oil to identify commercial uses, like soaps. Communities around Mount Mulanje have planted Mulanje cedar hedges from which essential oil can be extracted, and distillation equipment and training are currently being provided. This effort offers local communities alternative incomes from the Mulanje cedar that don't damage Mount Mulanje or its plant resources. The conservation team also planted ex situ trial plots and woodlots elsewhere in Malawi. These actions aim to ensure the planted trees on the mountain remain safe for the long term.

Whatever approach is taken to reduce threats, improve natural regeneration, or restore populations of the tree species, the full engagement and participation of local stakeholders is key to the success of all tree conservation initiatives. This ensures that the approach is appropriate to the local context, has local ownership and support, and is more likely to achieve a lasting impact.

Threatened Trees in Restoration

Trees capture carbon from the atmosphere—a fact that has drawn increasing interest given that runaway levels of carbon dioxide are a significant driver of climate change. And trees are also essential components of many habitat-restoration projects. As a result, governments and organizations around the world are investing in large-scale tree planting. These tree-planting pledges and restoration projects

Decomposition Hymn

by D. Allen

Close your eyes. Before lockdown, before the Holiday Farm fire, before you used a cane or shopped online for wheelchairs, before half your life was winter and the other half a recovery from winteryou hiked the narrow path into a green cathedral high in the Cascades wilderness, pressed yourself into the knotted roots of a douglas fir, and listened. It was eight years ago, and only once, but that day made a door inside you. On one side, time pulls your body deeper into the earth, fires sweep the forest, you mourn the living and tend the dead. On the other side, a waiting convocation of pacific silver firs, douglas firs, western red cedars, incense cedars, and hemlocks growing or fallen, bark and branches draped in moss as if the whole place just rose from an age in deep water. Up here, the research station is a half-remembered dream. You are the only human among migrating roughskin newts, douglas squirrels, three woodpeckers who tap out their rounds unseen. Beside your seat of fir needles and loam, a once-upright trunk learns its new role as food, home, shelter, witness. A barred owl's call electrifies the silence, and soon another answers from down the ridge until the whole forest vibrates in you. Syrinx to sapwood to spine. Remember how it felt to fill your lungs so deeply that your only sound was song?

> D. ALLEN is the author of A Bony Framework for the Tangible Universe (2019), a finalist for the Minnesota Book Awards. This poem was written about the H.J. Andrews Experimental Forest, with special thanks to Fred Swanson.

Botanic gardens and arboreta are in a strategic position at the intersection of research, outreach, and conservation.

provide an opportunity to deliver on conservation goals by incorporating threatened species into the planting plan. However, this opportunity is often missed; many tree-planting projects focus only on exotic species or, even in the case of restoration plantings, only a small number of native species.

At Jardim Botânico Araribá, in the State of São Paulo, Brazil, a team has been working on a forest restoration project since 1987, intending to restore not only specific plant species but also the entire ecosystem. The efforts at the garden are an exemplar of how threatened species can be incorporated into a successful restoration program. The garden is situated on one of the few remaining fragments of Atlantic Forest. Despite the status of the Atlantic Forest as an important biodiversity hotspot, this forest type is recognized as one of the most degraded ecosystems on the planet. So far, the garden staff has restored about fifty acres (two-thirds of the site). Due to this restoration, headwaters that supply water to Amparo, the closest city, have reappeared. The restored forest protects the riverbanks, preventing silt build-up and protecting the river water.

The restoration plantings at Jardim Botânico Araribá feature threatened species, including the endangered brazilwood (*Paubrasilia echinata*) and another critically endangered species in the legume family, *Chloroleucon tortum*. The plants for the restoration are grown in partnership with a commercial nursery that also supplies these native tree seedlings to customers for planting in their local area. As a result, the species are becoming part of the local supply chain of native tree species in São Paulo.

Scaling Up Conservation Action

With such a vast number of trees at risk of extinction worldwide, a significant scaling up of conservation action is urgently needed. To increase effectiveness and avoid duplication of effort, tree conservationists should mobilize at national levels. It's also crucial to coordinate efforts around specific taxonomic groups, especially genera or families with a high number of threatened species. Species within the same taxonomic group share many characteristics, and they may be subject to the same or similar threats. Therefore, related species are likely to benefit from the same conservation actions.

BGCI and the botanic garden community have established groups known as Global Conservation Consortia, which are developing comprehensive conservation strategies for highly threatened taxonomic groups identified by the Global Trees Assessment. The consortia aim to coordinate *in situ* and *ex situ* conservation efforts and disseminate species recovery knowledge. For example, the Global Conservation Consortium for Oak, led by The Morton Arboretum,

mobilizes experts and local partners to conserve oaks, a culturally and economically important taxonomic group that cannot be protected in seed banks. As part of these efforts, the team has organized educational webinars, provided training on seed collection and species propagation, and coordinated regional meetings and workshops focused on filling knowledge gaps for species of conservation concern. To date, Global Conservation Consortia have been developed for six tree groups: oaks (Ouercus), magnolias (Magnolia), rhododendrons (Rhododendron), maples (Acer), southern beeches (Nothofagus), and the dipterocarp family (Dipterocarpaceae). These groups include more than eight hundred threatened species, and the model is now also being applied to highly threatened non-tree groups.

National coordination of tree conservation efforts is also a valuable approach, as the collaborations in Kenya have demonstrated. The GlobalTree Portal allows tree conservationists to identify countries with high numbers of threatened tree species, especially those with high numbers of threatened endemics. These countries must be priorities for coordinated conservation. Indonesia, for instance, has almost seven hundred threatened tree species, with ongoing habitat- and species-level threats providing little chance for their recovery without dedicated conservation action. While many large-scale conservation programs are dedicated to the country's flagship animals (such as elephants, orangutans, and tigers) or to large areas of high-carbon forest, few initiatives are specifically designed around the conservation needs of individual threatened tree species in situ.

Through the Global Trees Campaign, FFI has successfully engaged the Indonesian government in threatened tree conservation. As a first step, FFI established the Indonesian Forum for Threatened Trees, a group of more than seventy members from at least thirty different institutions. The forum convinced the Ministry of Environment and Forestry to consider adding twelve threatened tree species to their list of priority species. So far, one of these trees, a critically endangered dipterocarp known as Vatica javanica ssp. javanica has become legally designated as a National Protected Species. In 2019, the Forum for Threatened Trees and the Indonesian Institute of Sciences published a ten-year national conservation strategy for the twelve priority species. At the same time, FFI also seeks to build capacity for organizations working on threatened trees and inspire new action for priority species.

Mobilizing a Global Community

In contrast to the numerous well-known flagship animal species, threatened trees have gained little attention from governments, funders, conservation organizations, the corporate sector, and the public. With 30 percent of tree species shown to be at risk of extinction, this needs to change. Tree conservation requires a concerted response from the global community, with all different regions and sectors engaging and taking action. Botanic gardens and arboreta are in a strategic position at the intersection of research, outreach, and conservation and can play a critical role in safeguarding the world's tree species. The urgency of the situation, however, requires an "all hands on deck" approach.

Policymakers at all levels (global, national, and local) need to incorporate and prioritize threatened trees within legislative frameworks. Intergovernmental and international organizations need to promote and share data from the Global Tree Assessment with their networks and integrate threatened tree conservation into their programs. The corporate sector has an expanded role to play, particularly companies engaged in timber, agriculture, and extractive industries. Land managers, including governments, are key actors in securing critical habitat. Members of the conservation organizations need to prioritize threatened trees within their programs, supporting action on the ground and generating a higher profile for this issue. The tree-planting and habitat-restoration sector have an unrivaled opportunity to integrate threatened trees within their work, contributing significantly to saving species while meeting their other goals. There is a role, too, for the research community. Researchers are necessary for filling information gaps on threatened species and demonstrating the role of tree species diversity in ecosystem resilience. Moreover, there is a need for committed individualsglobal citizens who advocate on behalf of threatened trees. Now is the time to act. 🧶

FURTHER READING

BGCI & FFI. 2021. Securing a Future for the World's Threatened Trees—A Global Challenge. BGCI: Richmond, UK.

SILVIA ALVAREZ-CLARE is the director of global tree conservation at The Morton Arboretum. KIRSTY SHAW is the head of ecological restoration and tree conservation at Botanic Gardens Conservation International. SARAH POCOCK is the programme officer for plant conservation at Fauna & Flora International. COLLECTIONS IN PRACTICE

The Making of Arboretum Wespelaar

By Philippe de Spoelberch

hether an arboretum has ten trees or thousands, many of the same management concepts hold true. Yet new collectors often progress through trial and error, as though no one else had gone through the same process. I began raising trees from seed in my garden in the late 1960s. As with many mad collectors (no matter what is being collected), I started the whole thing without much forethought—it just began one day. But I kept going and expanded the collection into neighboring woods and meadows. In 2003, I established Arboretum Wespelaar as an independent institution in a small village north of Brussels, Belgium.

My family had operated the Artois brewery for generations, so I was fortunate to have the means and the space to begin such a collection. (Artois is now part of Anheuser-Bush InBev, and we are today just long-term family shareholders.) I also had the opportunity of starting early, having good advice from my father, who loved trees, and I was curious and determined to know more. I remember my father kidding me because I did not immediately see the difference between a young beech (*Fagus*) and hornbeam (*Carpinus*) or, worse, a spruce (*Picea*) and Douglas fir (*Pseudotsuga*). I would not get caught again.

I returned to Belgium in 1969, after getting a graduate degree in business administration from Columbia University, with 150 seedlings in a big bag. In those days, you could carry about anything on a plane. Most of the seedlings had germinated in a wooden Borden milk box on the terrace of my apartment in New York. I had collected others during a trip to California just before my return. Fifty years later, the redwood (*Sequoia sempervirens*) from that trip are the tallest and girthiest trees on the estate and arboretum.

While working as a young brewery salesman in my late twenties, I visited dozens of gardens and arboreta around the world. I started buying Artois Pond welcomes visitors into the tree collections at Arboretum Wespelaar. All photographs courtesy of Philippe de Spoelberch



plants at local nurseries and then European specialist nurseries. The collection spread from the garden around my house (twenty-five acres) into what was to become the arboretum (eventually fifty acres). For the first twenty-five years, I had the help of a single gardener. Now, five-full time gardeners manage the arboretum and the nearby garden at Herkenrode. Over the years, we learned by doing.

Preparing the Ground

When we began, two kinds of areas were used: meadows and woodlands. Both needed some kind of intervention. I learned this at my expense. Our first foray into the woodlands was done without concern for honey fungus (Armillaria mellea), which causes root rot. As trees were cut to open vistas, we left stumps, and the fungus soon got the best of many choice plants. We did not make this mistake when extending the collections into the old oak wood now in the arboretum: All shrubs and undergrowth were removed with a rotary cutter and uprooted. All deadwood was removed. We did not have additional honey fungus problems, but this exercise did little for the soil structure. It took years before moles arrived, finally suggesting improvements in soil structure and aeration (performed by millions of worms).

The old meadows required a different approach. Cattle had trampled and compacted the soils. As a result, it was necessary to plow these areas before planting. In one case, we even allowed a local farmer to grow corn for two seasons. Without soil preparation, the plants sulk, never sending roots beyond the planting hole and eventually drowning there, at least in a flat part of the world like Flanders. After plowing, we created mounds and planted the trees upon them, allowing the water to drain. Initially, it looked as if I was trying to create a minigolf course, but visitors were kind enough to say that the whole thing was not too ridiculous. By now, the result is spectacular. You can easily see that the trees planted on mounds are at an advantage, and the movement in the terrain provides some visual appeal.

Sourcing the Plants

I have long enjoyed plant propagation. Like many kids, I was fascinated with seeing seeds burst into growth. I was even scolded in school for growing wheat in the inkpot of my desk. The arboretum and the nearby gardens currently contain almost eleven thousand living accessions of woody plants. Of these, By now, the result is spectacular. You can easily see that the trees planted on mounds are at an advantage.

50 percent were raised by us from seed, cuttings, and collected seedlings. Many originated from expeditions to the wild. My first trip was to Nepal in 1975, and successive annual trips (often with the International Dendrology Society) have targeted every possible temperate locale, from California to Hokkaido.

When seeds arrive throughout the autumn and winter, we place them straight into the refrigerator. A numbered label is added to the individual bag and accompanies the seed through subsequent steps. The label is essential. (It is embarrassing to admit that you do not remember the origin of a beautiful plant.) The seed lots accumulate until March, when they are sown in pots. Of course, many seeds could be sown outside when they arrive (the cold, moist winter conditions are generally suitable for this), but mice will always find them and have a feast. Ungerminated seed pots should be allowed to go through another winter, because belated surprises can always be expected. Seedlings are repotted when big enough to withstand the shock (two or four true leaves above the cotyledon) but basically when we have the time. Seedlings can stay crowded in a pot for many months.

As a precaution, always split a collection of rare seeds into several lots and treat each set differently.



The meadows of Arboretum Wespelaar were regraded to encourage drainage and provide visual intrigue. Here, Artois Pond emerges.

Some twenty years ago, I received a hundred seeds of a recently discovered species of magnolia (*Magnolia decidua*, then known as *Manglietia decidua*) from China. I kept fifty seeds and distributed the others in equal sets to five good propagators and magnolia enthusiasts. One morning, I had a look at my tray and realized that a fungus had killed all fifty seedlings. I was hoping that my five colleagues would have succeeded. One had died; one did not remember receiving the seeds. Of the others, Tom Hudson (of Tregrehan Garden in Cornwall) and Dick Figlar (of the Magnolia Society International) had managed to grow the seedlings and are responsible for all specimens of this species in cultivation, including the one at Arboretum Wespelaar.

Cuttings are collected between the end of May until mid-August. Every time we purchase a plant, we immediately take cuttings, given that cuttings from young plants often root more easily. For example, I took cuttings on a young *Magnolia* 'Elizabeth' three years in a row; out of five cuttings taken each time on the first, second, and fourth year, we succeeded at propagating five, two, and then none. The winter months are hard for the cuttings; even perfectly rooted cuttings will decay under the attack of fungi. Healthy white roots go brown, and the base of the unhardened cuttings does too; the cutting dries up. We have not been very good at keeping our cuttings growing, but these losses can be a relief. We still end up with too many plants: some five hundred cuttings and seedlings every year, which will have to be looked after for another three to ten years.

Small seedlings can be collected along roads and edges of woodlands. These will travel well if kept in relatively dry moss, packed in plastic bags or plastic water bottles. (Obviously, you must be respectful of rules and legal restrictions.) We also purchase plants, mainly in pots. The smaller, the better. I have had much disappointment with large plants. Small plants are, of course, cheaper and can be grown to a good size in one of our nurseries until ready for final planting in the arboretum.

Planting the Landscape

We have used three temporary nurseries around the garden and arboretum. Good woodland soil and shade from large trees provide the ideal growing conditions for our small plants and seedlings. It is ideal to observe your plants until they have suffered a bad winter. It gives you the time to decide



A numbered label accompanies each plant from the moment it is planted at Arboretum Wespelaar. A separate inventory is used for seeds and cuttings, many of which are shared with other gardens.

The arboretum and the nearby gardens currently contain almost eleven thousand living accessions of woody plants. Of these, 50 percent were raised by us.



Numbered playing cards provide a quick visual cue when siting plants in the landscape.



Trees are a family affair. The author and his grandson participate in a conservation planting in Madagascar, managed by Madagaskari Voikaji.

where to plant them. They will transplant with a good lump of soil (unlike the miserable peat ball with circling roots that you find at the average garden center). We have seldom failed in transplanting a young tree or shrub raised in these woodland nurseries. On the other hand, we have lost many plants in the first few years in these sites. But better there than in the grounds after an expensive effort at planting!

We rarely place a plant directly into its final location. Most spend as long as five years in the nurseries. Few people like the idea; it seems like double work. But I consider not taking this intermediate step to be a grave mistake. Many recently acquired plants will die, and given this reality, I like them to die in the nursery. I have often thought it would have been much better to collect art of any kind and, like a dendrologist, throw two-thirds of the collection away and enjoy the remaining successes. At least, works of art generally gain value over time, whereas aging trees become an expensive problem.

When it comes time for siting the plants, we use a homegrown method involving playing cards. I do not know who came up with the idea, but we have used it for fifty years. We staple two sets of plasticized playing cards (reds and blues) onto plants in the nursery. The identity of the plant and its card is written up on a special form. A corresponding set of playing cards is placed on 104 bamboo sticks, which are reused for several years. We then take a walk through the grounds, staking locations for each of the plants. We aim to get rid of all the bamboo stakes while trying to remain intelligent and effective and still get home in time for dinner. It takes us, in general, up to five hours to place two sets of cards. Of course, we could write the plant's name on the stick, but it is much easier to spot the cards from a distance.

We often situate the plants in taxonomic groupings. So, when we're placing the bamboo stakes, we first attempt to place a viburnum, for instance, within the viburnum section. If there is no space left, we find room elsewhere. Obviously, you must know what condition the plant enjoys, how big it will become, and so forth. One becomes better at this with time, but the proper planting distance is always a terrible illusion. Someone once pointed out that when there was a gap between two trees and you add a young tree between them, you end up

Arnoldia | Spring 2022

I do not need to see my trees in old age; I know what they will look like. Other plant collectors are more impatient.

with two additional gaps. I must admit that I have found myself planting two new trees in such spaces. Discipline is essential.

Large trees should be planted at least fifty feet apart, yet we have many at half that distance. We will remove one of them in due course. Trees should not be planted near the edge of a woodland, or they will grow slanted. Likewise, groups of three—an arrangement beloved by landscape architects—should be avoided as none of the three will end up as a balanced specimen. (This is not a problem for shrubs and small trees.) These conservative approaches will make your arboretum look rather dull for many years, so you have to suffer the irony of friends and guests. Most do not understand what is going on. I like to think that I do not need to see my trees in old age; I know what they will look like. Other plant collectors are more impatient.

Cataloguing and Labeling

When beginning a catalogue for a plant collection, it is a good idea to think carefully over what software to use and then leverage its capabilities to the greatest extent. These days, you may want to consider using relational database software, but a single spreadsheet can be equally effective. Take some time to sit down and think over the structure. Some curators will suggest that at least twenty fields are necessary, but I recommend a minimum of six: accession number, name, landscape location, source, date planted, and condition. Most people will also want a field for any supplementary information. The printed catalogue at Arboretum Wespelaar presently uses nine fields, out of some twenty in our Access database.

Accession numbers are a difficult concept for beginning dendrologists. I do not know why. An accession number is no more than a simple and unique sequential number given to each plant that comes into the collection. You can give the same number to several plants provided they are from the same source, same age, and in the same location. But otherwise, give them unique sequential numbers, or you will soon regret it. Further, there is no reason to include the date within the accession number.

Of course, everyone will want to know the age of a plant. Most curators will include the date of planting on the label, which is a good idea. But we made the mistake of including the date as part of the accession number: Our first plant bears accession number 66001, which means it was the first accession in 1966. This system was useful until the year 1999. With the millennium, we got in trouble, as the first plant of the new millennium was 00001. And it shows up first in any numbered list. We had to add two digits for the sequential listing.

When it comes to the name, it is best to refer to a single accepted list, thereby avoiding spelling errors and nomenclatural issues. The Royal Horticultural Society's *Plant Finder* is probably the only document to be sufficiently comprehensive and regularly updated. Synonyms and taxonomic changes of names are clearly indicated in annual updates. It even includes cultivated varieties. Still, if you specialize in a certain taxon (like magnolias), you may want to use a recent monograph on that group.

Once this record-keeping is complete, then comes labeling—the curator's nightmare. I have always had an average memory and have not relied on it to know anything. This is probably why I have been so determined to make sure that our plants are properly labeled. Our labels include the name and accession number and are made on a thick ribbon of white PET plastic cut to length and engraved with an automatic engraving machine (a Gravograph). Labels are inexpensive: we estimate that it cost us one euro to make a label with a reasonably long name.

Labeling problems, however, are never far away. I learned plants while visiting arboreta and botanical gardens all over the world. As I explored these collections on my own, I would go to a plant, take a picture, and then search for a name. I would be exasperated if I did not find a label and sometimes astonished at the number of wrongly labeled plants I encountered. Even so, at Arboretum Wespelaar, one of our members on a study day was surprised to find a label stating *Abies rufinerve* on a new maple accession. (*Abies*, of course, is the genus of fir trees—the tag should have read *Acer rufinerve*.) So problems occur even in the best houses.

Change in the Collection

Arboretum Wespelaar, like any plant collection, is in a constant state of evolution. Not only do plants grow and die, but interests and goals shift as well, changing the landscape over time. Although I fell in love with conifers initially (my first plant was a white fir, *Abies concolor*, accessioned in 1966), I soon switched to deciduous trees, particularly maples. Around 1969, I went to a local nursery that had a seemingly good catalogue and proudly ordered one of each maple on their list. I soon found that my collection of some twenty maples was far from what the world had to offer. Would I have given up if I had realized that there were more than 120 species, along with hundreds of hybrids and cultivars? My subsequent loves were rhododendrons, magnolias, and stewartias, as proven by the number of those plants in the collection. Today, the team at the arboretum aims to acquire all of the main species in all important genera and in particular plants from wild origin.

It is clear that gardens, if well-curated, can contribute to the maintenance of biodiversity. The Franklin tree (Franklinia alatamaha) is a memorable example: although it went extinct in the wild in the early 1800s, the species survived in Bartram's Garden in Philadelphia. While conservation is an additional objective of Arboretum Wespelaar, our primary purpose is to ensure that people can study and learn to love plants. We have no shop, no cafeteria, and nothing for children. Dogs and joggers are not welcome. The result is that our visitors actually look at labels and take notes. I have always intended that the garden and then the arboretum should be open to the public, recognizing that I have benefited from the generosity of botanists, plant collectors, and gardeners who have opened their collections to me. In turn, it's my pleasure to welcome others and inspire them to see and know plants.

Once a year, usually in November, we have a difficult day when we deaccession trees, removing them from the collection. This year, we will likely deaccession around fifty plants. These are painful choices but very necessary. We have planted too much with the knowledge that we would have failures and that others wouldn't last. I am adamant that as many as possible of our trees should have lower branches on half of the crown. In due course, aesthetic considerations will always rule above other imperatives. Within a changing collection, it is always nice to have too many good things. *#*

PHILIPPE DE SPOELBERCH is the past president of the International Dendrology Society, the founder of Arboretum Wespelaar, and the president of Fondation Franklinia, an organization devoted to the preservation of threatened tree species. For additional information on collections at Arboretum Wespelaar, visit the www.arboretumwespelaar.be.

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Propagations

TREE TIME

A Time for Trees, A Time for Arboreta

by Gerard Donnelly

Planting and watching trees grow takes time. A long time. The lifespan of a tree may be the equivalent of multiple human generations. This is the good and patient work of arboreta, which requires considerable time horizons to achieve many of their purposes. At The Morton Arboretum, in Lisle, Illinois, we call this "tree time." The time required to establish, test, and evaluate tree collections and develop beautiful, planted landscapes that inspire people's interest and appreciation is such that only long-term, multigenerational organizations like arboreta can undertake them.

Given these timescales, I like to say that it is good to be old if you are an arboretum. This year, The Morton Arboretum is celebrating its centennial year, having been established by Joy Morton in 1922. Morton had been encouraged and advised by Charles Sprague Sargent of the then-fifty-year-old Arnold Arboretum of Harvard University. The Arnold Arboretum is celebrating its sesquicentennial year, founded in 1872, the same year Morton's father, J. Sterling Morton, established Arbor Day in Nebraska. The Arbor Day Foundation, created fifty years ago, in 1972, upon the Morton-family legacy of planting trees, is advocating for tree planting on the occasion of its anniversary with a theme of "A Time for Trees."

The time for trees has arrived. There has never been a time when recognition of the value of trees and tree planting was greater than it is today. Trees are being planted globally at scale to sequester carbon and cool the planet. There is widespread appreciation for the ecosystem services that trees provide in urban areas by filtering air pollution, cooling hot cities, and mitigating stormwater pulses. Numerous scientific studies show how trees contribute to human health and well-being.

Yet time has not been good for trees over the past 50, 100, and 150 years. Burgeoning human activities have drastically reduced the size and health of the world's forests as well as the diversity of trees and myriad other organisms that depend on them. In addition, climate change is already impacting trees through altered weather patterns, violent storms and floods, drought, and ravaging forest fires. Trees—long-lived, stationary organisms—are highly susceptible to climate change because growing conditions are changing at rates that can stress and exceed tolerances and adaptability within their lifetime.

How serious is the threat? The recent *State of the World's Trees* report by Botanic Gardens Conservation International (BGCI) is alarming. Based on the organization's Global Trees Assessment involving contributions from arboreta across the globe, including The Morton Arboretum, the report documented that 30 percent of the 58,497 known tree species in the world are threatened with extinction.

With the majority of the world's population now living in cities, urban forests are recognized as key assets to ensure healthful, sustainable, and climate-resilient communities. However, urban centers are challenging settings for trees to grow in and survive, let alone flourish and contribute their full complement of benefits to people, communities, and the environment. Also, trees and their benefits are not equitably distributed across urban landscapes—they often reflect the disparities of resources and human demographics.

Climate change, tree extinction, tree planting, urban forestry, and environmental justice are significant challenges that all arboreta can play a key role in addressing. But the magnitude of these issues requires the power of coordinated collaboration to have a meaningful impact. No single arboretum can do it alone.

For this reason and others, ten years ago, The Morton Arboretum established ArbNet as a global network of arboreta. By working together, arboreta can be better equipped to champion the cause of trees. ArbNet has identified more than 2,100 arboreta in 133 countries, all of which have a common purpose of collecting and showcasing the diversity of trees and promoting their planting and conservation.

ArbNet offers an arboretum accreditation program that recognizes standards of professional practice at four different levels of institutional capacity, encouraging the achievement of higher levels of development over time. Lockerly Arboretum in Milledgeville, Georgia, provides a good example. Initially accredited at level two in 2017, Lockerly used ArbNet accreditation standards to set development goals, including the creation of a new horticultural internship program and expanding participation in scientific research. Upon meeting these goals, Lockerly achieved level-three accreditation in 2021. ArbNet helps member institutions exchange information, expertise, and models that others can use or adapt for their purposes.

Climate change threatens trees as well as the arboreta that maintain living collections of them. Arboreta need to conduct tree performance evaluations and risk assessments to prepare for predicted changes in growing conditions. We also need adaptation strategies that include relocating species, varieties, or specimens to arboreta with more suitable future growing conditions. ArbNet can play a key role in this. Rather than have such exchanges handled variably on a case-by-case basis, an organized system and standardized process are needed to Over tree time—in 50, 100, or 150 years—curators will use these collections to ensure that the species are safeguarded from extinction risks.

> optimize these adaptive plans. The Morton Arboretum envisions a coordinated climate adaptation strategy and program for trees among the arboreta and tree-focused gardens in North America.

> ArbNet's interactive network also provides an opportunity to test tree science questions using a "common garden" approach at arboreta in different growing zones and environmental conditions. One example of this approach is a North Dakota State University study to evaluate adaptive variation among sets of genetically identical poplars (Populus) growing at eighteen arboretum and university sites across the United States (including the Lockerly Arboretum). Researchers are using whole-genome sequencing and climate modeling to predict how plants will respond to different climate conditions in the future and inform management approaches to build climate resiliency.

> To halt the extinction of threatened tree species, arboreta must commit institutional resources and staff expertise. We must coordinate with one another on targeted tree conservation efforts, including through programs like the Global Conservation Consortia organized by BGCI. A prominent example

is the Global Conservation Consortium for Oak led by The Morton Arboretum in collaboration with BGCI and dozens of arboreta and other partners involved in oak conservation. No single arboretum or garden can or should conserve all the world's threatened oak species, so a coordinated, global effort is needed. As part of these efforts, The Morton Arboretum is establishing conservation groves on-site for two threatened species from the southeastern United States: Georgia oak (Quercus georgiana) and mapleleaved oak (Quercus acerifolia). Over tree time-in 50, 100, or 150 years-curators will use these collections to ensure that the species are safeguarded from extinction risks, and researchers will study what can be done to help them survive in nature.

Tree planting has risen to the forefront as a solution to blunt global climate change, given the ability of trees to sequester carbon from the atmosphere. Yet large-scale tree plantings for carbon sequestration often take the form of low-diversity tree plantations or forestry plantings that do nothing to protect tree biodiversity; they may even diminish it. Arboreta must lend their expertise in tree diversity, planting, and horticulture to improve approaches for carbon-focused tree planting and reforestation efforts. A new global biodiversity standard for large-scale tree plantings being introduced by BGCI will position arboreta and other botanical gardens as key resources to achieve these essential outcomes, ensuring effective carbon capture in addition to-not at the expense of-biodiversity conservation.

Arboreta also have an important role to play in supporting objectives to plant trees in urban environments to ameliorate heat, filter pollutants, mitigate stormwater flooding, and lower energy costs. Urban forests also add beauty and improve social cohesion, human health, and well-being. Arboreta know how to cultivate trees in designed and managed landscapes, but they must assert their involvement and influence with municipal planners, engineers, and landscape architects to enhance opportunities to develop healthy and sustainable urban tree canopies.

Gerard Donnelly is the president and CEO of The Morton Arboretum, in Lisle, Illinois.

When arboreta partner with community organizations and local government agencies, they can play a meaningful role in addressing the disparities in people's access to the environmental and health-related benefits of a thriving urban forest. Although this issue was not at the forefront of efforts by arboreta or botanical gardens fifty or one hundred years ago, arboreta should now actively seek funding (or commit their own resources) for equity-focused tree plantings that engage residents in participatory planning and provide training for tree planting and care. Arboreta can partner with tree nurseries and growers to provide not only the diversity of suitable trees needed for urban conditions but also at the sizes that can be managed in community and volunteer planting efforts.

Furthermore, and aligned with the goal to engage and serve a broader spectrum of the public, arboreta must actively foster and support career paths associated with the work of an arboretum to new and different groups of people. Only with a diversified pipeline of tree experts, curators, scientists, horticulturists, conservationists, and educators will arboreta fully serve the public good.

Arboreta, with their beautiful trees and landscapes, attract a substantial public audience and provide immersive experiences and learning moments about the value of trees and nature. These are opportunities to register tree time—the time it takes for a tree to reach its full potential over 50, 100, or even 150 years. These long timelines require commitments to tree planting for future generations, sustained efforts to protect them and their growing environment, and actions to address climate change and other tree threats.

The grand challenges of our time related to trees require arboreta and tree-focused botanical gardens to collaborate actively. Together, these institutions can achieve more meaningful and successful impacts, engaging their vast collective audience to encourage people to plant and advocate for trees and a more sustainable world. The year 2022 is certainly a time for trees—and for arboreta. *#*

The Strangeness of Trees

by Jonathan Damery

he general form of a tree—trunk, branches, twigs, leaves is so commonplace as to be completely unremarkable. Trees inhabit spaces that most of us experience daily, and, in fact, they often create those spaces. A low, widespread, and rather twisting elm stretches its branches over the patio of a café, not far from my apartment. It forms an enchanted ceiling, especially in the spring, when the samaras alight in the branches. Any tree we encounter is likewise defining its space. We move around them, beneath them, and sometimes even upon them. We're so familiar with trees that, for some of us, they feature in our earliest memories. In my case, it was a ten-foot-tall apple tree in a neighbor's backyard. (I filled a bucket with the forbidden fruit and was ordered to return it-with an apology.) For Emanuele Coccia, an associate professor at the École des Hautes Études en Sciences Sociales, it was a trio of Italian umbrella pines viewed from the balcony of his childhood bedroom. He calls them his "first image of the world."

Coccia recounts this memory in Trees, a book designed for an exhibit of the same name at Fondation Cartier, a contemporary art museum in Paris. The large-format book, published in an English translation, is the kind that you might see stacked on a coffee table in a furniture catalogue. It's filled with almost five hundred images, including field sketches, conceptual paintings, and film stills. Often, when parsing meaning from an artistic depiction of a tree, we turn to a standard suite of metaphors. We see the ancient oak, gnarled and twisted, as a symbol of endurance and solidity. We see a small tree growing from broken concrete as a reminder of perseverance. Scholars might examine specific depictions through the lens of post-colonial studies or otherwise. Yet many of the writers and artists who contribute to Trees suggest that, first and foremost, we must acknowledge trees' status as living beings, reconsidering the strangeness of their too-familiar forms.

Stefano Mancuso, the Italian biologist who is a prominent figure in the controversial field of "plant intelligence," leads this charge, pointing out the bizarro ingenuity of plant life. "Like the negative of a photo, what is white in the animal world is black in the plant world," he writes. "Organisms that are so different from us that, as far as we are concerned, they may as well be aliens that evolved on a different planet." Mancuso enumerates many of the differences between the lifestyles of plants and animals, including differences pertaining to movement, of course, and our inverse needs for carbon dioxide and oxygen. He emphasizes one difference as especially noteworthy: the distribution of specialized functions. While almost all animals have organs that cannot be separated from the rest of the body, plants spread these functions across their form in repeating modules. Plants, for instance, respire without organs that resemble lungs. They digest food without anything that resembles a stomach. Given this functional distribution, a Kentucky coffeetree can lose a large branch from a lightning strike (another one of my early childhood memories) yet retain its ability to produce the organic compounds needed to continue living.

This phenomenon of distribution, Mancuso suggests, can cause us to discount the liveliness of plants. We recognize that plants are living organisms, yet we see little of ourselves in their structure. Although we know that plants die, many of us aren't exactly sure what it means for them to be alive. Distribution, we come to recognize, is fundamental to the forms featured in *Trees*.

Among the most maximalist works in the book are Luiz Zerbini's large-scale paintings that situate trees within a jumble of urban textures. Zerbini's *Mamão Manilha* shows a potted papaya (*Carica papaya*) growing alongside several bromeliads. Two papaya leaves sag along its trunk, preparing to join another that has already dropped to the ground. Above them, a bird opens one of several fruits, revealing the orange flesh and black seeds within, and

above that, white flowers appear in large, loose clusters. The painting not only captures the modular form of the plant-each leaf, each fruit, ultimately destined to be shed-it also captures how this disposability becomes central to a web of other biotic interactions. The pot suggests that a human had grown the papaya in anticipation of the fruit, yet, in a war of attractions, a bird won the harvest. A series of leaf scars along the papaya's trunk also reminds us of the seasons of growth and disposal that have led to this moment. The painting is a composite-an imagined place-vet the plant seems to be a singular individual, forging an existence that is less than glamorous but nonetheless alive.

The book also includes works by Indigenous artists from several regions in South America, including the Gran Chaco, the semiarid plain that sprawls between the Paraguay River and the Andes. The works from this region are ink and paper drawings, and almost all capture interactions among trees and other organisms. A fascinating untitled work by Eurides Asque Gómez shows lines of leafcutter ants trailing into their volcanic burrows carrying leaves of algarrobo trees (Prosopis nigra). The ants, in turn, are shown being picked off by partridges. According to the artist, who is quoted in an essay by Ursula and Verena Regehr, the partridges nest in grasses between the algarrobo, knowing that the ants are partial to the young leaves. Meanwhile, an ovenbird has built its nest in one tree, and birds perch on the branches of another. In this way, Gómez showcases not only the modular, throw-away nature of the trees' emerging leaves-a solution to being immobile targets for predatorsbut the way that their modular structures become essential to other organisms.

Moreover, *Trees* is a testament to the ways these omnipresent forms shape the lives of humans. Gómez and other artists often include people in the web of arboreal interactions depicted in their art. An atmospheric scientist, Abigail Swann, describes how trees influence climate, choreographing weather patterns—a fact



Trees.

Foreword by Bruce Albert, Hervé Chandès, and Isabelle Gaudefroy, exhibition curators.

Fondation Cartier pour l'art contemporain, 2019.

Jonathan Damery is the editor of *Arnoldia*. among many in the book that reminds us that our disregard for the imperiled state of trees may precipitate our own demise. Yet, on a personal level, the artists and essayists are, themselves, residing among trees, sometimes building livelihoods around their forms. The ensemble of individuals includes landscape designers, a mathematician, the film director Agnès Varda, the American artist Charles Gaines, and many others.

Yet it is the botanist Francis Hallé whose lifelong engagement with trees is most clearly documented in the pages. Hallé offers forth drawings from field notebooks, prepared in rainforests around the world: Sri Lanka, Côte d'Ivoire, Peru, and elsewhere. In some sense, these field sketches represent the leaves of Hallé's career, collected and pressed within the covers of dozens of notebooks that he has labeled by date and location. "You quickly realize that the shape of a tree, even when young is never random," Hallé says in an interview with Coccia. "Each species has its own 'architectural model,' that is, a tree's growth and development follow a genetic program."

Hallé's drawings endeavor to capture these unique forms. Among his most impressive works is a large drawing on tracing paper titled Forest Profile, which depicts dozens of trees growing in relationship with one another in French Guiana. He provides two views of the forest: from the side (a cross-section that shows the complex layering of tree canopies) and from above (showing the locations of the tree trunks and the spread of their branches). Even in this schematic form, Hallé captures each individual's species-specific, non-random shape. His empirical approach seems like it would produce results that are more like traditional scientific illustrations, often beautiful but unsurprising. Yet through his careful attention to detail, and the disambiguation of these overlapping forms, Hallé captures what many of the other artists in Trees likewise reveal: the strange reality of the still lives of trees. 🧶



ENVIRONMENTAL JUSTICE

by MaryLynn Mack

s an African American woman who has worked in public gardens for the past eighteen years, I often experienced firsthand the need for greater diversity. The lack of inclusion in the workspace is not an issue exclusive to public gardens, but it should be noted that many public gardens in the United States were founded by white people and many are primarily staffed by white people, despite being located in communities of color. Like many of my friends and colleagues in other industries, I was often asked to be the representative for all people of color when discussing inclusion, diversity, equity, and access (a set of issues often known as IDEA). Being the "only" in a room was disconcerting, but it also gave me access and opportunity to speak on important matters and empowered me to do my own self-reflection, do my own research, and do my best to connect and engage with as many communities as possible.

Over my years working in gardens, I found myself having conversations with employees at other botanic gardens and arboreta who also served communities not reflected in their boards, staff, and volunteers. I may have been an "only" in my workspace, but I was far from alone to bring forward the need for change. The American Public Gardens Association (APGA) also had conversations with its members and took

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the call to action to begin a more authentic discussion about the bias, barriers, and baggage in our industry. APGA is the leading professional organization for the field of public horticulture. Members include more than ten thousand individuals at over six hundred institutions, in all fifty states, the District of Columbia, Canada, and twenty other countries. The organization's primary goals are to encourage best practices, offer educational opportunities, and advocate for members, so this dialogue was a crucial step toward action for public gardens as a whole.

In 2016, a group of eleven truth-seekers scheduled a phone meeting to talk about diversity and inclusion. This group wasn't appointed, but we were individuals who had asked questions or nudged the association to "do something." We represented generational, ethnic, gender, racial, and sexual-orientation diversity and worked in gardens throughout the United States. Only a handful held a high-level leadership position in their respective gardens. This inaugural group spent the first twenty minutes dissecting the definition of diversity. Through that process of discovery, we unearthed the varying degrees of knowledge, the chasm of feelings and opinions, and a quick understanding of just how different we all felt on how to move forward. While at times uncomfortable, we realized that within that uncomfortable space, we could reflect on our own bias. Thus began a year-long exploration of reading diversity articles, untangling historical perspectives steeped in garden history, and having informal chats about our own experiences while serving public gardens. The work was difficult and sometimes frustrating, without a guidebook of boxes to check.

It is important to note that regardless of where gardens and their staff stand in their work towards inclusion and diversity, everyone must start by addressing what they do not know. Starting with a garden's history, for example, gardens should bring to light what the land was before, and who lived on it and cared for it. One resource With a mere five minutes before the session started, we had to request more chairs—the room was already packed. that is especially helpful when exploring this issue is a book, edited by Duane Blue Spruce and Tanya Thrasher, titled *The Land Has Memory: Indigenous Knowledge, Native Landscapes, and the National Museum of the American Indian.* It speaks to the rich history and contribution of indigenous people to the land in the Americas and is a thoughtful representation of how traditional Indigenous ways should be put into practice by cultural institutions.

Increasing individual knowledge in these and other areas is crucial. This work helps combat the collective unawareness that exists when members of a group believe that others in their group hold comparably more or less extreme attitudes. beliefs, or behaviors. The term "unawareness" is not meant to disparage the work currently happening in gardens but is a reminder that the work needs to start with recognizing that the struggles of communities of color are not new. Allies must take advantage of resources that include research reports, academic studies, and courageous conversations that bring to light past disparities.

After a year of self and group discovery, the IDEA committee made plans to involve the membership at the APGA conference held in Hamilton, Ontario. Our inaugural session was scheduled for eight in the morning on Saturday, a tough time slot since it was the last day of a weeklong conference and the morning after the traditional evening farewell celebration. We were nervous and truly had no idea how our stories and messages would be received. The agenda was informal: committee members had decided to simply introduce the topic of diversity and share personal experiences. With a mere five minutes before the session started, we had to request more chairs-the room was already packed. What happened next showed us that public gardens were ready and eager for change.

In that crowded room, we had executive directors of large gardens, first-time attendees, educators, gardeners, and outreach coordinators who worked directly licly accepted a challenge to move forward in the work. Many conversations continued in the corridor after the session. We were all so excited, but we all had the question: What in the world needed to happen next? Inclusion and diversity work is often slower than people might hope for. It takes

in their local communities. We listened,

shared personal vulnerabilities, and pub-

slower than people might hope for. It takes time to develop authentic relationships, actively listen, and recognize that every public garden has different obstacles to overcome. It also takes time to build trust. Patrick Lencioni, author of Five Dysfunctions of a Team, writes about this, describing team-building steps that also work when creating a more inclusive environment. The fear of being vulnerable is often a barrier when speaking on matters of race, diversity, and equity, yet showing vulnerability builds trust in conversation and in relationships. Asking questions that allow people of color a safe space to share their experiences of microaggressions, gaslighting, and other forms of bias are first steps toward changes needed in the workspace and the garden.

A few years ago, I had the opportunity to speak on diversity and inclusion at the Botanic Gardens Conservation International Congress in Warsaw, Poland. During the open time for questions, one attendee expressed his concern when broaching a conversation about race with someone in the workplace. This person was afraid of using the wrong words, saying the wrong thing, or inadvertently offending a colleague. We discussed the need to acknowledge your own bias and privilege, but then I ended by stating that you just need to "step in it." Not my most eloquent moment, especially since I was attempting to encourage this person to step bravely toward having the conversation rather than becoming immobilized and missing an opportunity to have an authentic exchange. Yet that became my tagline and the start of many meaningful conversations for the duration of the conference. This work is messy, imperfect, wonderful, and needed.

We discussed the need to acknowledge your own bias and privilege, but then I ended by stating that you just need to "step in it."

Many public garden leaders have embraced this need for diversity and inclusion and entered into the work with vulnerability and passion. Brian Vogt has built a framework that infuses IDEA throughout every aspect of Denver Botanic Garden's operation, where he is the chief executive officer. For over ten years, the garden has devoted themselves to IDEA principles with board and staff committees, as well as extensive relationship development resulting in eighty partner organizations. When describing their approach at the garden, Vogt notes how they "emphasize the power, not the pain, of IDEA work." Today, their visitors reflect the diversity of their community as does the board itself, which is now 40 percent non-white. These changes have resulted in programming that lifts up diverse voices, exhibits, and communications. Vogt further emphasizes, "Don't get distracted-authentic diversity and inclusion work makes everything better."

Other gardens initially take an external approach and achieve sustainable results. Bruce Harkey, the president and chief executive officer of Franklin Park Conservatory and Botanical Gardens in Columbus, Ohio, led an effort to improve the quality of life in the community by creating neighborhood-based outreach and educational programming. One recent example is the conservatory's participation in the HeART of the Protest, where the King Arts Complex produced forty-six days of artistic projects to honor the forty-six years of George Floyd's life. Franklin Park Conservatory hosted performances by dancer Candice Igeleke and musician K. Daniel. These events presented new work that focused on telling the story of Black Americans, from slavery to present day. Franklin Park recently added an internal focus: the board, leadership team, and staff work in unison to honestly assess their diversity, equity, and inclusion status. They then set goals and objectives for measurable improvements.

These and countless other examples show that our gardens are embracing change. After APGA's initial group session in Hamilton, members expressed a growing interest to hear and do more when it came to IDEA principles and practices. The following year, in 2018, when the IDEA committee presented at the Southern California conference in a capacity-filled ballroom, it became apparent we were more than ready to make inclusion a collective goal. The next year, in Washington, DC, the entire conference theme was Diversity. This resulted in a week-long conference filled with panel discussions, lectures, and facilitated sessions surrounding topics about diversity, equity, accessibility, and inclusion in our gardens and beyond.

One key moment happened during our very first IDEA Café, a keynote luncheon where a group of esteemed panelists talked about their own experiences in public gardens. One of the panelists was in a wheelchair and needed to use the elevator to get backstage. With mere moments before the group was to take center stage in front of an audience of hundreds, the hotel manager received a radio call that the elevator was stuck with our panelist inside! The situation was rectified but we decided to use what happened as a teaching moment. This was an example of how accessibility issues are always present and can impact a person's experience in significant ways. These shared experiences and conversations inspired us to build systems and best practices for the APGA sustainability index, gather feedback and success stories from gardens, and provide encouragement for those gardens who are just beginning to address these issues.

I smile recalling Brian Vogt's charge to "embrace the work of diversity and inclusion joyfully." It is good advice. While our work with inclusion will never be done, the past two years have taught us that collective resilience and embracing change will sustain us along this journey. As I think about the diversity of plants in my garden, which experience stress and environmental adversity year after year, I'm amazed by how they somehow adapt and persevere through it all. They are resilient, and so are we. ##

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SEASON IN PRACTICE



Balling and Burlapping

By Chris Copeland, Greenhouse Horticultural Technologist

15:1

The proper ratio between the root-ball and trunk diameters.

65 percent

A root ball must have a depth of at least 65 percent its diameter. Transplanting is a delicate process that ideally occurs during dormancy, at the beginning or end of the growing season. In the Arnold Arboretum's nurseries, we use traditional methods to ball and burlap our field-grown trees. To preserve the proper ratio between roots and shoots, we measure the diameter of the trunk: for every inch, we need a minimum root-ball diameter of fifteen inches. Because we cannot input every factor into an equation, we also exercise judgment, accounting for the tree's height and the anatomy of its root system.

Once we have determined the diameter, we sever the roots with a sharp spade and excavate a trench. The root ball should be deep enough to ensure that taproots are retained—at least 65 percent the diameter. We shave away excess soil to minimize transport weight. The exposed root ball is wrapped with burlap and secured with sisal, using a drum-lacing pattern. We carefully rock the tree, freeing it from the soil below. At this point, the tree is ready to go. *#*

A spring dig with Jed Romanowiz and J. Scott Phillips. Photograph by Andrew Gapinski



The ARNOLD ARBORETUM of HARVARD UNIVERSITY

125 ARBORWAY BOSTON, MA 02130-3500 "There has never been a time when recognition of the value of trees and tree planting was greater than it is today." – p. 55