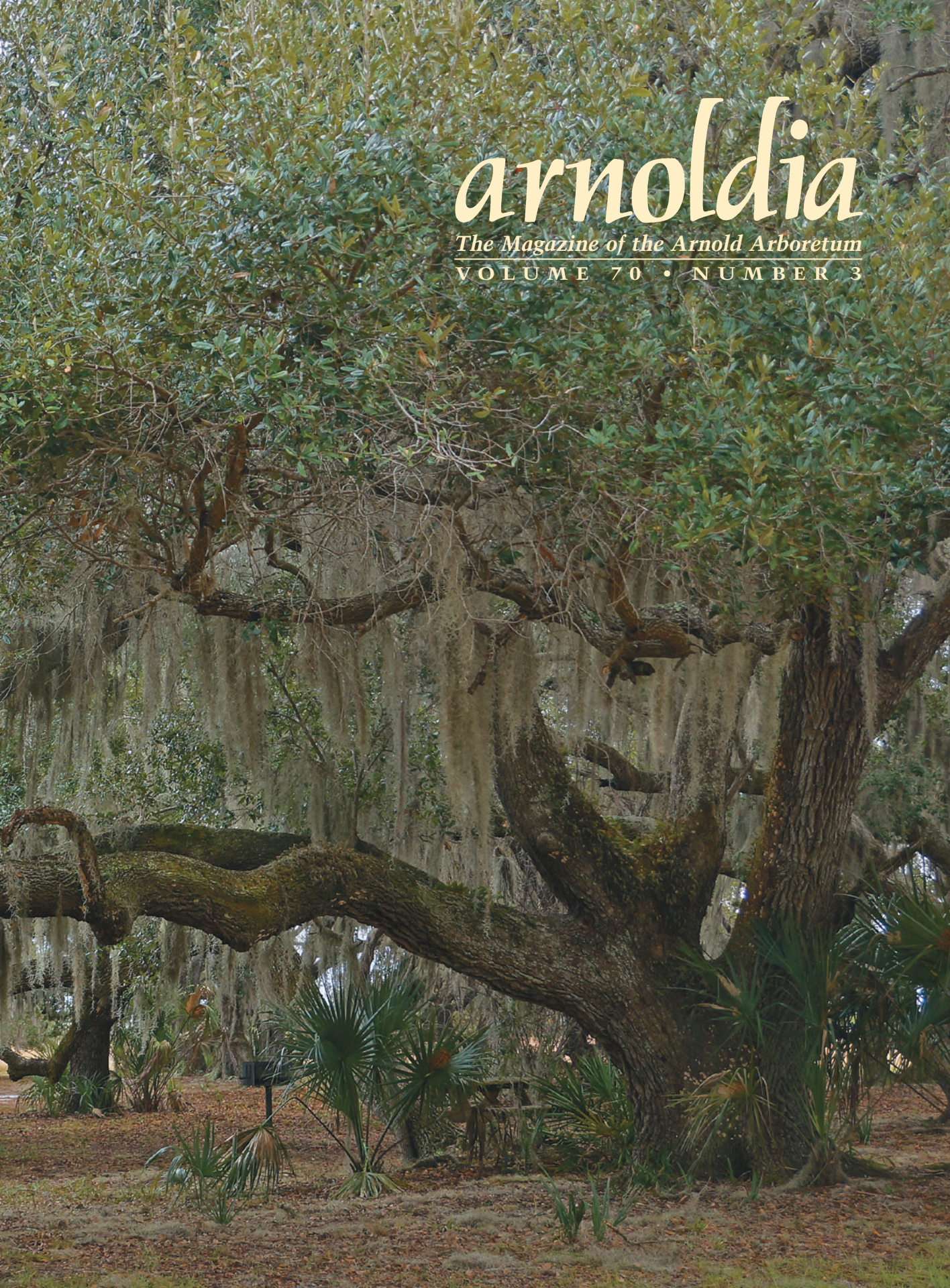

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Inside front cover: Blue flag iris (*Iris versicolor*) is one of many species recorded in a recent floristic survey of the Middlesex Fells, a unique nature preserve within the Boston metropolitan area. Photo by Nancy Rose.

Inside back cover: This Arboretum specimen of Dahurian birch (*Betula dahurica,* accession 1015-80-A) is of interest for its ornamental traits and its conservation value. Photo by Nancy Rose.

The Middlesex Fells, a Flourishing Urban Forest

Walter Kittredge

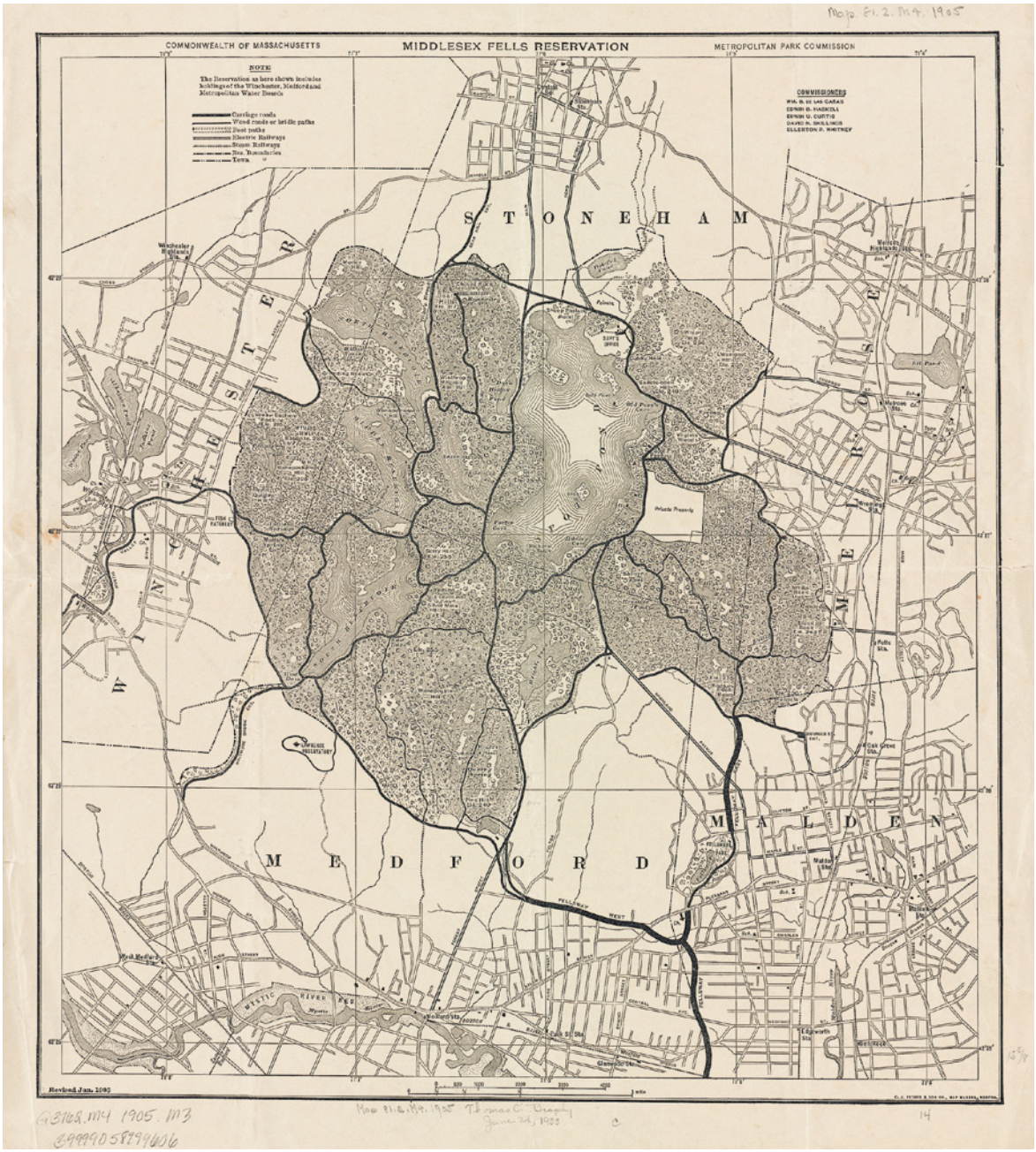
> **… five miles northerly of Boston lies a great tract of country, all stony hills and tablelands, almost uninhabited, and of wonderful picturesqueness, and wild, rugged beauty … The nature of this region cannot better be characterized than by the application of the old Saxon designation *fells,*—a common enough word in England, meaning a tract of wild stone hills …**
>
> **Sylvester Baxter, *Boston Herald Supplement*, December 6, 1879**

The Middlesex Fells is a forest of 3,400 acres just north of Boston, three-quarters of which is under the jurisdiction of the Massachusetts Department of Conservation and Recreation. It is one of four reservations that comprised the original Metropolitan Park System (MPS), the others being Beaver Brook, Stony Brook, and the Blue Hills. At almost eleven square miles, the MPS is one of the largest urban forest reservation systems in the world, only slightly smaller than the largest one in Rio de Janeiro.

The reservations were set aside beginning in 1894, after a long and determined conservation effort by many prominent area residents. This noteworthy group included Elizur Wright, who reformed the life insurance business, fern expert George Davenport, naturalist Wilson Flagg, journalist Sylvester Baxter, and renowned landscape architects Frederick Olmsted and Charles Eliot. They were aided in this effort by the Appalachian Mountain Club and the newly formed Trustees of Public Reservations. Their conviction that urban people needed a nearby reprieve from the city helped bring about this first-of-its-kind wild urban forest park system. Although Boston's Emerald Necklace (which includes the Arnold Arboretum and Franklin Park) preceded the advent of the MPS, the Emerald Necklace green spaces differed from the MPS in being

WALTER KITTREDGE

Bitternut hickory (*Carya cordiformis*) is fairly common in the Fells; this is the largest one at 32 inches (81.3 centimeters) DBH. It occurs in the newly designated Sugar Maple–Oak–Hickory Forest.



NORMAN B. LEVENTHAL MAP CENTER AT THE BOSTON PUBLIC LIBRARY

Middlesex Fells map from 1905.

intentionally cultivated landscapes. As Elizur's daughter Ellen wrote, "What we wanted in the Fells was a bit of nature so conveniently in our midst that we might watch its workings … we wanted dark crowded places, even jungles … marshes into which one might wade after reeds and bright berries, brooks where the border growth and waters frolic together …"

A TRACT OF WILD STONY HILLS

The Fells is a dissected upland with narrow north–south ridges and valleys. The highest elevation is Bear Hill at 317 feet (96.6 meters) above sea level, and the lowest is 65 feet (19.8 meters), where Whitmore Brook exits the Fells. The volcanic bedrock is part of the Avalon Terrane, an ancient Pangaean island chain

WALTER KITTREDGE

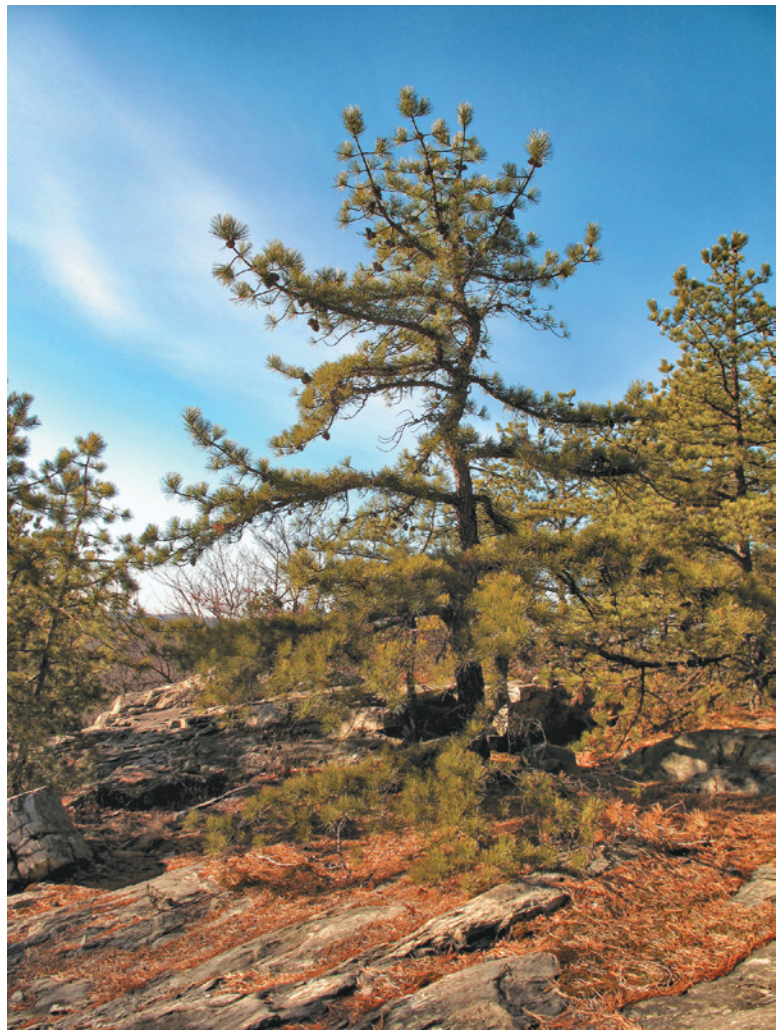
Pink lady's-slipper (*Cypripedium acaule*) flowers and fruits prolifically after fires, taking advantage of the extra sunlight and extra nutrients from the ash.

that collided with coastal New England and Canada. The resulting geological features are a complex of felsic lava hills (including Pine Hill) in the south, and plutonic domes of granite (including Bear Hill) in the north. The middle section of the Fells differs in having an overlay of metasedimentary rock. The southeast corner features a steep scarp along the North Boundary Fault, with panoramic views of the Boston Basin. One of the more intriguing geological features is the Medford Dike, a narrow valley of dark, mafic rock between Pine and Little Pine Hills, and the site of nineteenth-century quarries. The gritty gabbro rock from the quarries is called grus, and was used to line the paths of the Public Garden in Boston. There are also swarms of dark black Jurassic dikes, some of which can be seen in the cut side of Pine Hill along Interstate 93. Evidence of the glacial epochs remains in the form of numerous large erratic boulders, striations on the exposed bedrock, and the thin, stony glacial till soils. These poor soils, along with the steep topography, made farming so difficult that few people made their home there. The main use of the Fells was for timber and firewood, resulting in its forests having been cut over many times by 1894. It is noteworthy that despite this, there are areas that have many trees over 3 feet (0.9 meter) DBH (diameter at breast height), the largest one being a red oak (*Quercus rubra*) at Bellevue Pond with a DBH of 4.8 feet (1.5 meters).

About one quarter of the Fells is water, mainly in the form of reservoirs, which provide drinking water for the surrounding communities. The largest is Spot Pond, a glacial kettle pond of 294 acres, so named in 1631 by Governor Winthrop for its many small islands. This, and several other open and covered reservoirs, are operated by the Massachusetts Water Resources

Authority. The three reservoirs on the western side of the Fells were created out of the large Turkey Swamp before the reservation was set aside, and are owned (along with the adjacent land) by the town of Winchester. All of these reservoirs were included in both the original floristic survey of 1894–1895 and our recent 2003–2011 survey headed by Bryan Hamlin. Most streams in the Fells are small, but Spot Pond Brook had enough drop in elevation to provide water power for many small-scale industries. The Fells falls within the Mystic River watershed, which makes up over half of the Boston Basin Ecoregion. This ecoregion includes the city of Boston, and has had 80% of its land developed. The Fells and Lynn Woods represent the only large blocks of native forest left in this ecoregion, forming isolated islands of natural vegetation in a densely populated area.

The climate is in USDA Plant Hardiness Zone 6a (average annual minimum temperature -5 to -10°F [-20.6 to -23.3°C]), with average annual precipitation around 41 inches (104 centimeters). Climate change is evidenced by increasing temperatures in the Northeast; the Boston area has been warming at a rate of 0.5°F each decade since 1970, which has significantly extended the growing season. Photographic records made during the nine years of this survey support this, documenting increasingly earlier bloom times. Average annual precipitation in the Northeast increased 8% in the twentieth century, mainly occurring in the last forty years. The proximity of Interstate 93 and the densely populated surrounding towns contribute to local air pollution, which can have a particularly negative effect on sensitive lichens. Doug Greene and Elizabeth Kneiper recently surveyed the lichens in the Fells and found 110 taxa, indicating that the forest is doing a good job of purifying the air.



MIKE RYAN

Ridgetop Pitch Pine–Scrub Oak communities are a very common prioirity habitat on rocky summits, especially in the southern portion of the Fells.

A STORIED HISTORY OF BOTANIZING

The Middlesex Fells provides a forest panorama of changing seasons for the thousands of Boston area commuters who drive through it on either Interstate 93 or State Route 28 (the old Andover Turnpike), both of which bisect it. It was on the latter road that William Boott arrived in the 1850s to stay at a hotel on the south end of Spot Pond and become the first to botanize the area. Before it was made into a reservoir, Spot Pond was shallow with a muddy bottom, which is reflected in the greater diversity of aquatic plant taxa Boott collected compared to today. Lorin Dame and Frank Collins would follow in his footsteps

MIKE RYAN

A rocky summit along Rock Circuit Trail in Middlesex Fells, looking northeast to nearby Boston suburbs.

in the 1880s, collecting plants for their *Flora of Middlesex County, Massachusetts.* After them came the fern specialist, George Davenport, whose favorite haunt was Pine Hill in Medford, the home of Elizur Wright, who pioneered the preservation of the Fells.

When the Metropolitan Park System was created in 1894, amateur botanist and landscaper Warren Manning, who worked for the Olmsted company, was given the job of organizing a floral survey of all four reservations. He brought together twenty volunteers to conduct field work and collect plant specimens. Among them, amateur botanist William Rich of Boston was the chief collector in the Fells. The well-respected local botanist Walter Deane was then hired at the end of 1895 to compile a "preliminary" flora from the survey's sightings and specimens. Deane based his 1896 *Flora of the Blue Hills, Middlesex Fells, Stony Brook, and Beaver Brook Reservations of the Metropolitan Parks Commission, Massachusetts* on the sixth edition of *Gray's Manual of Botany,* published in 1890, and consulted with Drs. Fernald and Robinson of Harvard University's Gray Herbarium. For our survey we relied mainly on Haines's 2011 *Flora Novae Angliae* in draft and published form.

In the winter of 1895–1896 Deane helped found the New England Botanical Club (NEBC) in response to the collaboration between amateur and professional botanists, most of whom didn't know each other prior to the survey. The newly formed NEBC herbarium eventually provided a home for the survey vouchers, including over 300 Fells specimens. I am currently engaged in creating a database, including images, of all the survey vouchers through a Museum and Library Services Grant. The specimens will then be linked to archival materials in the library, such as Manning's letters to surveyors and Deane's card file of sightings and specimens. For the current Fells survey over 350 specimens were collected, which will also be deposited in the NEBC herbarium.

In 1917, Nathaniel Kidder, then president of the NEBC, proposed a follow-up survey to the Deane *Flora.* He was unsuccessful in getting support for the project, and so pursued it on his own from 1919 to 1924. Kidder focused on collecting the plants that had been reported in 1896 but hadn't been vouchered with herbarium specimens, and new plants that hadn't been reported. Although he never produced a report of his work, his specimens represent a valuable contribution to our knowledge of the reservation's flora, documenting new arrivals and overlooked plants, and verifying the *Flora* sightings.

RECENT FLORISTIC SURVEYS

Deane's *Flora* reported a high level of biodiversity in the Fells, but a 1996 article by Drayton and Primack indicated an alarming loss of species. The article was based on a centennial study of part of the western Fells, done in the early 1990s by Brian Drayton for his master's degree. In the early 2000s, Bryan Hamlin began to question the validity of the 1996 report, after finding many of the "missing" plants in the area of study. As a result, he began a systematic resurvey of the entire Fells, assisted by Betty Wright, Don Lubin, and others. At an NEBC meeting in 2006, Bryan Hamlin told me that he was working on a new flora of the Fells, and I agreed to help him with the difficult graminoid taxa—the grasses, rushes, and sedges. Over time, the current survey became a community effort among members of the NEBC, with a long list of local botanists contributing their expertise, very much like the original collaboration that led to the formation of the Club.

For his survey, Drayton excluded ferns, graminoids, and aquatic taxa. Comparing the same set of plants from the same area, our survey found 564 taxa (355 native), while Drayton and Primack only reported 331 taxa (244 native) with a "loss" of 155 taxa since the Deane *Flora.* Our survey was able to find 105 of these reportedly lost taxa, 83 of them within their study area. The most likely reason for this large discrepancy was that Drayton's survey consisted mainly of a single person surveying for only 300 to 400 hours over three years, versus our team effort of about 2,000 hours over nine years.

Drayton's work was also hindered because he wasn't allowed to collect specimens, which could lead to misidentifications. A large study of surveying techniques found errors of misidentification averaged about 5%, and that overlooking plants averaged 17%. After examining the Deane *Flora* vouchers, we found about a 4% error rate in misidentification. As stated in our *Rhodora* article, "The level of expertise of the surveyors, the level of teamwork, and man-hours spent surveying all affect accuracy."

For the 1890s survey, Manning defined four frequency categories—common, frequent, occasional, and rare—that the surveyors then reported according to their individual qualitative assessments. In order to create a quantitative measurement of frequency, we divided the Fells into eight approximately equal-sized sectors. Based on the number of sectors in which a plant was found, it was scored as common when found in seven to eight sectors; frequent in five to six; occasional in three to four; and rare in one to two. In order to obtain these data we conducted what were in effect eight mini-surveys. Our examination of Deane's *Flora* and vouchers showed 680 vascular taxa (570 native, 110 non-native) for 1896, while our survey found 868 taxa (563 native, 305 non-native). This comparison of the two survey totals shows a tripling of non-native plants. While there was little net change in native plant numbers, there was a significant change in the composition. One hundred twenty-five native taxa that were reported in 1896 were not found by our survey, while we discovered or reconfirmed 119

BRYAN HAMLIN

The parastic American squawroot was singled out by Deane as being the rarest plant in the Fells. It has since increased significantly in frequency, as we found it in five out of eight sectors.

new native plants. Remarkably, the relative number of plants in each frequency category was very similar for both surveys. This equilibrium in frequency and native plant numbers is indicative of a robust and dynamic ecology that is capable of supporting a high level of native diversity over time, despite the influx of non-native plants. It compares very favorably to other urban areas that have been recently surveyed, such as the Massachusetts towns of Needham and Worcester, which have experienced losses of 24% and 17% of native taxa, respectively, and more closely aligns with the rural flora of the Greater Mount Holyoke Range at 4.5%.

ECOLOGICAL CONSIDERATIONS

In order to better understand the diversity of the plants we were finding, we also included a survey of the plant communities. This was greatly aided by the descriptions in the 2001 Natural Heritage and Endangered Species Program (NHESP) Classification of the Natural Communities of Massachusetts. To determine which community types existed, various ecological criteria were observed in 100-square-meter (1,076.4-square-foot) plots, including elevation, slope, aspect, hydrology, bedrock, and soils, as well as the presence and abundance of plants occurring there. It was possible to make historical comparisons with the current communities using a 1905 map titled "Forest Plan for Middlesex Fells Reservation, 1896" prepared by Olmsted and Olmsted, which outlined where various woody plant associations had occurred.

Over thirty different habitats were documented in the Fells, ten occurring in wetlands and twenty in the uplands. Nine of these habitat types were priority communities, those which are considered for monitoring and protection by the state. Four of

MIKE RYAN

There are over 100 Vernal Pools in the Fells with a great diversity of hydrology, making the Fells a hotspot for this priority habitat.

ALEXEY ZINOVJEV AND IRINA KADIS (SALICICOLA.COM)

Nodding ladies'-tresses (*Spiranthes cernua*) varied in abundance from year to year during the recent Fells surveys.

these were not previously known to occur in the Boston Basin Ecoregion, and two of them were newly designated during the course of this survey. One of these was Sugar Maple-Oak-Hickory Forest, which is similar to Rich Mesic Forest, and only occurs on the south side of Bear Hill. The most prominent priority habitats were Rocky Summits, Pitch Pine Scrub Oak Communities, and Vernal Pools. Over 100 vernal pools of varying size and hydrology have been identified, making the Fells a hotspot for vernal pools.

The great diversity of habitats in the Fells can be accounted for by the diversity of geology and topography, in turn resulting in a high diversity of plants. Given the loss of land and the changing habitats over time, it is not surprising that there would be a significant change in the composition of the flora. The cessation of logging has allowed the forest to mature, with some areas starting to approach the characteristics found in old growth forest. Within the forest matrix, frequent anthropogenic fires continue to create a patchwork mosaic of different aged successional growth contributing to diversity. These burns have been kept small by the suppression of fires since the 1920s, which, along with increasing rainfall, has led to the overall favoring of mesophytic plants like beech and maple. During our survey a beaver dammed Whitmore Brook, creating a pond and marsh out of a red maple swamp, which resulted in an influx of new plants. Our survey found wetlands plants to be particularly opportunistic in responding to varying water levels and habitat succession.

Studies of urban forests have found that the rarer plants with low population numbers are more susceptible to local extirpation. In the Fells about 60% of the taxa that were rare in 1896 are still extant, and almost half of those have increased in frequency. There are two state-listed rare species and eleven others which are watch-listed as potentially becoming rare in the state. Most of these rarer plants are herbaceous; woody plants are generally more abundant and more persistent. Some of the rare plants are ephemeral in nature, depending on successional habitats, and can come and go in a single season. We observed that orchids like

NANCY ROSE

Wild columbine (*Aquilegia canadensis*) is common in woodlands throughout the eastern United States and Canada, including Middlesex Fells.

nodding ladies'-tresses (*Spiranthes cernua*) that were locally abundant in one year often went dormant and were very scarce the next. Other rare plants are restricted by only growing in habitats that are uncommon in the Fells.

One of the factors that contributed to loss of plant populations was the replacement of the native oak forest around the Winchester Reservoirs with non-native evergreens. Another factor was construction. When Interstate 93 was built through the middle of the Fells in the late 1950s it destroyed a large area that included the only large fen habitat. A less obvious yet important negative factor is fragmentation caused by recreational overuse. There are 36 miles of fire roads and 75 miles of trails in the Fells, with a large proportion of these trails being created by users, resulting in very few large trailless areas. This extensive network of trails is an avenue for invasive plants to become widely established, evidenced by their abundance along the trails.

WALTER KITTREDGE

Invasive vines such as Oriental bittersweet, porcelainberry, and English ivy (pictured here) smother the native herbaceous ground cover and can also climb and overtop trees and shrubs.

WALTER KITTREDGE

One year after it was cleared of English ivy, this area is already beginning to recover as the native ground cover regrows.

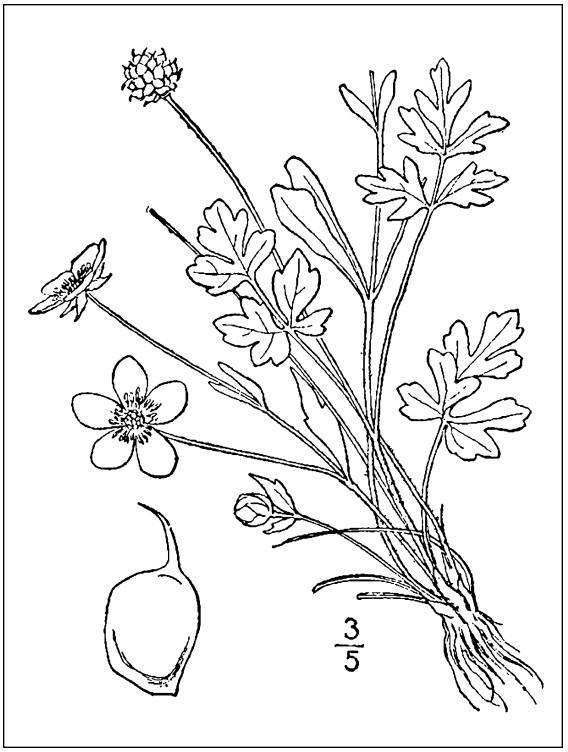


Illustration of early buttercup (*Ranunculus fascicularis*) from *An illustrated flora of the northern United States, Canada, and the British Possessions* by Britton and Brown, 1913. The single small population of early buttercup growing on Bear Hill was crowded out by invasive plants despite efforts to save it.

This is because foot traffic spreads seeds, and birds often use trail openings to travel, depositing seeds along the way.

The Fells is an island surrounded by a cultivated urban area, such that non-native plants are constantly entering from nearby plantings. Some of these plants are highly destructive of habitats, chief among them being vines such as Oriental bittersweet (*Celastrus orbiculatus*), porcelainberry (*Ampelopsis glandulosa* var. *brevipedunculata*), and English ivy (*Hedera helix*), which completely smother all other vegetation. Despite the inroads of invasive plants, the Fells has so far proved to be a robust system that has sustained a high diversity of native plants. The concern we have, though, is that without a significant effort to contain the increasing spread of invasive plants, native diversity may be severely reduced. Already, the locally rare early buttercup (*Ranunculus fascicularis*) has succumbed to invasive plants.

Diseases have also contributed to altering the forest ecology, with chestnut blight reducing American chestnut (*Castanea dentata*)—once a towering forest tree—to sprout growth, and beech bark disease beginning to reduce the fruiting of American beech (*Fagus grandifolia*) trees. The loss of both chestnut and beech fruit has had a negative impact on wildlife. Invasive insects like the hemlock woolly adelgid have also had a huge impact on the forests. Just as at the Arnold Arboretum's Hemlock Hill, these insects have decimated entire groves of mature hemlocks in the Fells, resulting in their replacement with a successional habitat of young sweet (black) birch (*Betula lenta*). On the other hand, the arrival in the Fells of the beneficial

beetles (*Galerucella* spp.) that eat purple loosestrife (*Lythrum salicaria*) has helped reverse the advance of this invasive plant, which was dominating wetlands. Although the deer population is relatively small, it still has had a negative effect on native lilies, which are also eaten by the non-native scarlet lily beetle (*Lilioceris lilii*). Other insects that pose potential future threats to the Fells forest include the emerald ash borer (*Agrilus planipennis*) and Asian longhorned beetle (*Anoplophora glabripennis*). Research in biological controls is ongoing and may eventually aid in controlling these highly destructive insects.

THE NEVER-ENDING FLORA

With our current survey of the Fells we have endeavored to make good use of Manning's intention to provide future generations with a long-range understanding of its dynamic flora. The Fells is a constantly changing system in which plants come and go, and for that reason no survey is ever 100% complete. In the year since we concluded the survey, we have found a further 23 taxa, 9 native and 14 non-native. This reflects the reality of overlooking, especially of difficult taxa like the graminoids and hard-to-detect rare plants like the three-lobed violet (*Viola palmata*), which we walked by dozens of times before noticing it. The high number of additional non-native plants we found confirms our observation that these are continuing to arrive at a rapid pace, but the finding of more native plants also supports the existence of a robust mature ecology in equilibrium. While past policies of passive forest management have allowed it to evolve naturally, a more active management would aim to protect sensitive priority habitats, reduce fragmentation through trail closures, and remove invasive plants.

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The Quest for the Hardy Southern Live Oak

Michael S. Dosmann and Anthony S. Aiello

CHRIS EVANS, IL WILDLIFE ACTION PLAN, BUGWOOD.ORG

Southern live oaks (*Quercus virginiana*) draped with Spanish moss line the road at Wormsloe, a historic colonial estate in Savannah, Georgia.

It's no secret that individual plants within a species can vary in appearance—just peruse the range of Japanese maples (*Acer palmatum*) for sale at your local nursery. All belong to a single species, yet show diversity in traits like growth habit, foliage color, and leaf shape. It's also old news that individuals can vary according to provenance (geographic source); winter hardiness is frequently noted as one of those variable physiological traits. Although he was not the first to note this phenomenon, botanist and plant explorer Joseph Hooker provided an early description in1853. In an introductory essay preceding his notes on the flora of New Zealand, he described differences in the hardiness of Himalayan plants, "depending upon the altitude at which they were gathered." Specifically, "some of the seedling Pines whose parents grew at 12,000 feet appear hardy, whilst those of the same species from 10,000 are tender. The common scarlet *Rhododendron* of Nepal and the North-west Himalaya is tender, but seedlings of the same species from Sikkim, whose parents grew at a greater elevation, have proved perfectly hardy." A few years ago, we wrote about C. S. Sargent's interest in acquiring cedar of Lebanon (*Cedrus libani*) germplasm that would prove to be hardy in Boston (Aiello and Dosmann 2007). He succeeded by obtaining seeds from Turkey, and those plants and others from that region have fared notably well in Philadelphia and Boston as well as colder climes, while accessions from other provenances have failed.

The cedar of Lebanon story points out the ongoing importance of plant exploration, a vital component of the missions of our respective arboreta. When adding accessions, we want to capture as much variation as possible within a species, so we often collect from multiple populations within a species' range. This is standard practice for species in our core, or high-priority, collections that are already well adapted to our local Arboretum conditions. However, for species like *C. libani* that are not typically winter hardy in our climate, we must seek specific provenances that may hold hardier populations.

One of those marginally hardy species that has evaded our grasp so far is the southern live oak (*Quercus virginiana*), whose massive, gnarled form—often draped in Spanish moss

(*Tillandsia usneoides*)—conjures up images of the antebellum South. This oak often exceeds 50 feet (15.2 meters) in height, but it is the spread that typically draws our attention. Almost always wider than tall, the colossal sweeping branches of old trees are a marvel. The common name "live oak" refers to the typically evergreen leaves, stiff and shiny on the top, and gray-tomentose on the bottom. However, during particularly cold spells the species may shed some of its leaves and is regarded as brevideciduous. Tolerant of drought as well as soil salinity and salt spray, southern live oak is often categorized as a "tough plant," aside from winter hardiness issues.

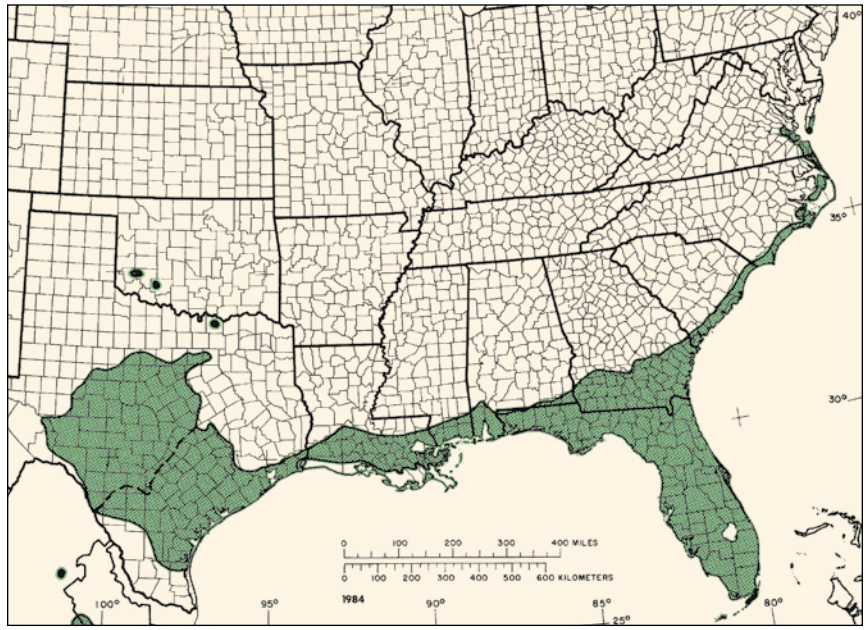
ALL PHOTOS BY THE AUTHORS UNLESS OTHERWISE INDICATED

***Quercus virginiana* has leathery, usually evergreen leaves.**

THE QUEST BEGINS

In 140 years of acquiring and testing species from all over the temperate world, the Arnold Arboretum has never even *attempted* to grow *Q. virginiana.* That the Arboretum had tried—and failed—to establish hardy plants in the collection is one thing, but to never even try? That was a surprise. The situation was similar at the Morris Arboretum, where *Q. virginiana* acorns were received in the mid-1950s as part of the ambitious Michaux Quercetum project. Acorns from several collections germinated and were planted in the oak nursery, but none of these survived to be grown on because, "mortality during the first winter [in the nursery] was extremely high, and no trees survived the second winter" (Santamour 1960). With this history at both arboreta, we determined that it would be worth the effort to document and collect from trees that, like the special provenance of *C. libani* in Turkey, might be hardy for us in our respective regions.

Southern live oak is native to the southeastern United States, with a range that extends from central Texas and a few populations in southwest Oklahoma, all along the Gulf Coast and Florida peninsula, turning northward to follow the coasts of Georgia, South Carolina, North Carolina, and southern Virginia. Flint (1997) noted that while the species' useful range as a landscape plant is USDA Zone 8b (average annual minimum temperature 15 to 20°F [-9.4 to -6.7°C]), it can tolerate colder extremes like Zone 7b (average annual minimum temperature 5 to 10°F [-15 to -12.2°C]) but is unlikely to attain its full size and landscape value because of ice and snow damage. Recent research from



The native range of *Quercus virginiana,* from *Silvics of North America,* USDA Handbook 654.

Botanical illustration drawn by Charles Faxon, from *The Silva of North America* by Charles Sprague Sargent.

the lab of Jeannine Cavender-Bares at the University of Minnesota has yielded interesting information on its ecology. Her lab found that *Q. virginiana,* like many other temperate species, varies in leaf and stem hardiness as a function of latitude: the more northern populations possess greater hardiness (Cavender-Bares 2007; Cavender-Bares et al. 2011; Koehler et al. 2012). In these studies, the lowest temperature that plants were exposed to (and survived) was 14°F (-10°C), which is still warmer than the average annual minimum temperatures found in Philadelphia (Zone 7a, 0 to 5°F [-17.8 to -15°C]) or Boston (Zone 6b, -5 to 0°F [-20.6 to -17.8°C]).

We feel there is potential to grow this species in our collections, or at least make the attempt. For one, our average annual minimum temperatures have risen because of climate change and urban heat island effects (see textbox). Although this hardly places us in the banana belt, it warrants an attempt to grow *Q. virginiana.* Also, the northernmost population sampled by Cavender-Bares was from Goose Creek State Park, North Carolina, where notably cold temperatures have occurred (down to 9°F [-12.8°C] in 1904). Surely if these populations survived that weather event, they likely possess greater hardiness than was indicated in experimental testing. Lastly, our review of various checklists, atlases, and other resources revealed that natural populations could be found around Norfolk and Virginia Beach, Virginia, (particularly First Landing State Park), as well as a few points northward—over 90 miles north of the Goose Creek sampling sites.

We wanted to collect germplasm from the most northerly natural populations in Virginia. Because some of these populations are near (or even within) urban areas, it is especially important to collect acorns and grow the seedlings elsewhere in case these populations become threatened by development in the future. During our planning, we also learned of notable trees that were either remnant natural populations or planted specimens that had survived frigid winters. These included old specimen trees growing in Hampton and Williamsburg (where it reached -7°F [-21.7°C] in 1985), and Richmond (-12°F [-24.4°C] in 1940). Even if these trees were planted (and therefore did not represent a wild source), their potential hardiness makes them valuable. And for a few of them, their extreme age suggests they were derived from now-extirpated local populations.

TO RICHMOND

Our short trip (October 20th to 24th, 2012) to explore the Eastern Shore of Virginia started in Richmond and finished in Virginia Beach. Our first collection site was the campus of the University of Richmond, home of the Spiders. Upon arrival, we were impressed by the well groomed landscape, despite having hosted a football game the day before (they beat James

Immature (green) and fully ripe (brown) acorns of southern live oak.

Tony Aiello measures the diameter of one of three mature southern live oak specimens growing in Bryan Park.

Madison University, 35 to 29). We commented that either the students were notably well behaved, or the landscape services department worked through the evening hours.

Using directions provided by Professor of Biology John Hayden, we were able to easily find the various specimens, many of which had been planted in the last few decades. Although we had seen the occasional *Q. virginiana* before, this site gave us our first chance to really observe the species in depth. Our first two collections were from trees growing near Westhampton Lake. The first tree, rounded and spreading in form, was about 15 feet (4.6 meters) tall and twice as wide; we estimated that it had been growing in that location for 10 to 15 years. And it was loaded with acorns, most with bright yellowish green nuts and tawny brown caps. However, a few had started to turn the typical mature color, a rich burgundy-brown. The branches were dense, with short internodes, and thickly set with leathery, oblong to oval leaves. Considering their form and (brevi)evergreenness, we thought they would make great screens. As was our protocol for the entire trip, we gathered germplasm in the form of acorns, made herbarium vouchers from cut twigs (complete with the acorns), and of course jotted down copious collection details that pertained to the trees as well as the local conditions and environment. The second collection was from a nearby tree, smaller and younger than the first, but similar to another six growing nearby. Undoubtedly the campus was trying to establish a grove of these trees in this area. Before leaving the University, we located and collected from two trees, older than the first, which were growing near a dining hall.

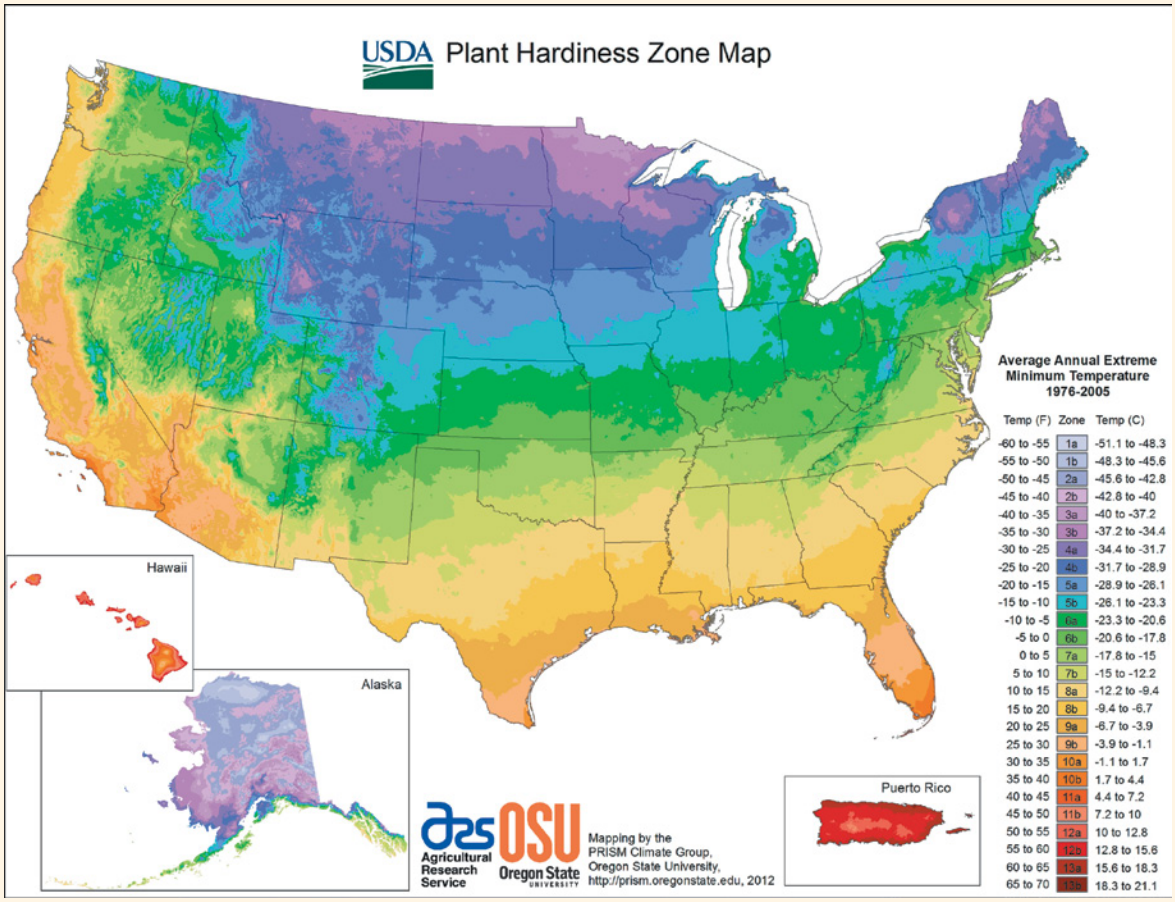
Changes in Plant Hardiness Zones

IN JANUARY 2012, the United States Department of Agriculture unveiled its new Plant Hardiness Zone Map (PHZM) (http://planthardiness.ars.usda.gov/PHZMWeb/), a development that was long anticipated by gardeners and researchers. Like its earlier incarnations, the new PHZM provides guidelines to predict a region's average annual minimum temperature, a vital statistic in determining whether or not a plant may survive the winter in a particular area. Last updated in 1990, the map now features a number of significant features. For one, it has gained interactivity through a Geographic Information System (GIS) that enables users to zoom in at regional and state levels; it also has a tool to identify a zone by zip code. Data quantity and quality represent marked improvement in the map's reliability— the new PHZM utilizes 30 years (1976–2005) and a wider geographic sampling of weather station data. (In comparison, the 1990 PHZM used data from only a 13-year period, 1974–1986, and fewer stations.)

Compared with the 1990 version, zone boundaries in the new edition have shifted in many areas, typically about a half-zone warmer from their previous designation (although some have shifted to a colder zone). Some of the changes are the result of the new, more sophisticated mapping methods and greater numbers of station observations, which has greatly improved accuracy, especially in mountainous regions. Additionally, in urban and suburban regions, the cities themselves can greatly influence temperature, resulting in heat islands that make them significantly warmer than their rural surroundings.

The data solidify the reality of climate change, suggesting even greater unpredictability with regard to future weather patterns and environmental conditions. The implications are significant not just for the natural world and those who study it, but also for gardeners. Warmer temperatures in the colder months can lead to further pest and disease outbreaks, as both are better able to survive in mild winters. Plants at the southern limits of their adaptability may eventually be negatively impacted to the point where they are useful solely at more northern sites.

On the positive side, warmer zones allow for an expanded palette of plants that gardeners can reliably grow. For instance, in Philadelphia there is now a better chance of growing traditional southern favorites such as crape myrtle (*Lagerstroemia* spp.), southern magnolia (*Magnolia grandiflora*), and Japanese camellia (*Camellia japonica*). In New England, the change in hardiness may



allow gardeners to reliably grow *Stachyurus praecox* and *Chimonanthus praecox*, which are currently hardy only in protected microclimates. And, if we are lucky, Philadelphia and Boston can add *Quercus virginiana* to that list.

Our next destination—after an amazing lunch at Buz and Ned's BBQ—was Bryan Park, a historic Richmond landscape founded in 1910. We expected to find small, rounded trees similar to those we had found at the University earlier in the morning. However, what we did find were three very large individuals, just down the hill from the Gatekeeper's House on the park's northeast side. Heights ranged from 30 to 40 feet (9.1 to 12.2 meters); each was rounded, usually twice as wide as tall, and with gnarled, twisting stems and branches. Only two of the trees (with dbh values of 35 and 39 inches [89 and 99 centimeters], respectively) bore acorns. Although we do not have any records to confirm this, based on their size we assume that the trees date back to the founding of Bryan Park and approach the 100 year mark. If so, they certainly would have survived the frigid winter of 1940.

TO WILLIAMSBURG

We departed Richmond in the early morning of October 22nd, and by 9:00 a.m. arrived at our next destination: the College of William and Mary in Williamsburg. Beth Chambers, curator of William and Mary's herbarium, was a great help to our efforts. Prior to our arrival,

Two mature southern live oaks east of the Wren Building on the College of William and Mary campus.

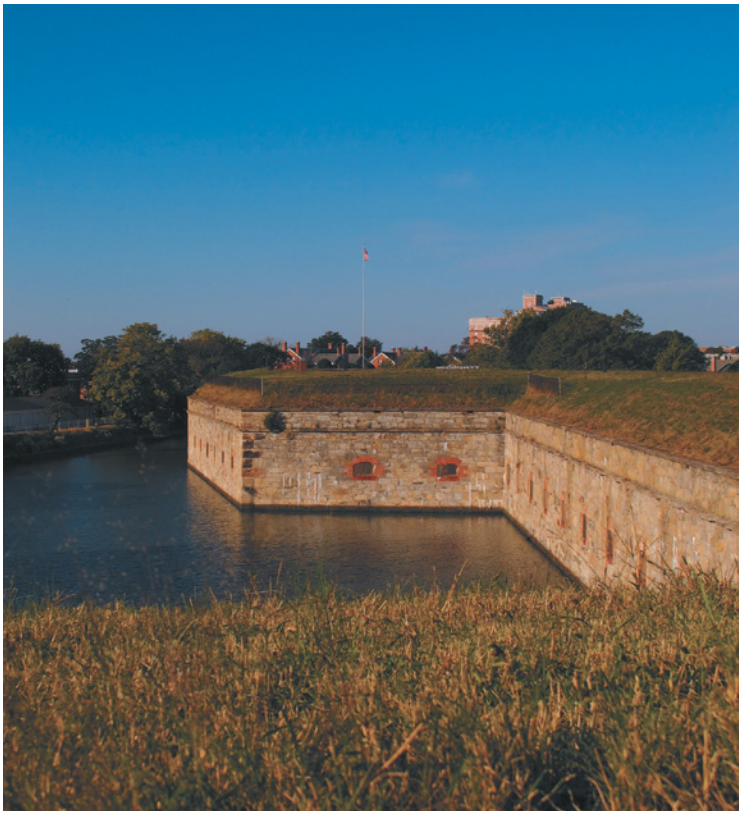
she scouted the numerous southern live oaks on campus, and even collected a few acorns in case there were none to be had by the time we arrived. She also accompanied us during collecting, providing assistance as well as anecdotes about the trees and buildings of this historic campus and neighboring colonial village. There were numerous southern live oaks planted on the campus, and their history dates to even before the founding of the university in 1693. The Corner Live Oak, a famous tree on campus, had served as a prominent boundary marker until its removal in 1943. Its age was estimated to be about 300 years at that time. Prior to its removal, acorns were collected and the progeny were planted around campus, including a prominent line along Landrum Drive (Mathes 1992).

The southern live oak legacy is also preserved in an 1836 watercolor of the Wren Building, a prominent campus edifice named after the famous architect Sir Christopher Wren, who *may* have designed it. When we arrived at the Wren Building, we were greeted by a towering *Q. virginiana* on the southeast corner. Although it had few accessible acorns, just to the east were several other large trees, the tallest nearly 40 feet (12.2 meters) in height. We collected seeds and vouchers from three of these specimens, two of which appear in a photograph from about 1875 (http://www.history.org/foundation/journal/Winter11/old_williamsburg/#3). A number of trees also grew off campus, in the Colonial Williamsburg section of town. We made two additional collections from these town trees, and also made the interesting discovery of the Compton oak, *Quercus* × *comptoniae,* a hybrid between *Q. virginiana* and *Q. lyrata* (overcup oak). We ascertained its identity from Terry Thon, a basket maker for Colonial Williamsburg, who has been routinely collecting acorns from it for years. This tree was an impressive specimen with a dbh of 60 inches (152.4 centimeters) and a spread of 100 feet (30.5 meters), and we were anxious to make a collection, too. [Editor's note: We'll have more on the Compton oak in a future issue of *Arnoldia.*]

THE OAKS OF FORT MONROE

During the trip's planning stage, Michael Dosmann spoke to Christopher Beagan of the National Park Service's (NPS) Olmsted Center for Landscape Preservation. Christopher described the amazing oaks of Fort Monroe and insisted that we visit this population and others near Hampton. He shared a few photos of the trees and we were instantly interested. He put us in touch with one of his NPS colleagues, Eola Dance, who is the Chief of Visitor Services and

A grove of old southern live oaks at the edge of the Parade Ground of Fort Monroe.



The moat surrounding Fort Monroe contributed to its defenses; mature southern live oaks can be seen growing within the fort's interior, above and to the right of the casement.

Resources Management at the Fort. We were thankful for the lead.

Perched at the ocean's edge, the Fort has a rich history that dates to the early seventeenth century. It had been occupied by the military until its recent decommissioning in 2011, and it is now a National Monument. The massive six-sided stone structure is the largest of its kind in North America: 63 acres of land surrounded by walls and an impressive moat. Construction of the current Fort took 15 years to complete and the final phase (finished in 1843) was overseen by Robert E. Lee. In an ironic twist, such was its fortitude that it was never lost to the Confederacy.

We arrived in the late afternoon of the 22nd to meet Eola, who enthusiastically showed us around the facility and explained some of its fascinating history. We also returned on the morning of the 24th to visit with her, as well as Joshua Gillespie and Robert Kelly of the Fort Monroe Authority. Inside the buttressed edifice we found a composite of former army barracks, period officer quarters, office and training facilities, storage buildings, a chapel, and a museum, as well as nearly 350 southern live oak specimens scattered throughout. Perhaps the most impressive is a large grove that grows along the south and west edge of the interior parade ground. Some trees stood as lone sentries, while others grew in small groups, sometimes arching over the sidewalks and defying gravity. Most were no taller than 35 to 40 feet (10.7 to 12.2 meters), and all had dramatic, ethereal forms, the result of decades and even centuries of difficult environmental conditions including drought, intense heat, and salt spray (even inside the fort's walls). No doubt, the grandest of these was the Algernourne Oak, a leviathan estimated to be over 450 years old. This tree has a basal diameter of 90 inches (228.6 centimeters), with two massive leaders diverging about 3

feet (0.9 meters) above the ground. True to the species' form, the tree's height is around 60 feet (18.3 meters), but its spread is nearly 100 feet (30.5 meters).

The acorns on all the oaks at Fort Monroe were few and far between, so we collected only herbarium vouchers from this representative population. We assumed that these trees produced few acorns because of the exposed, hot and dry location, and the droughty summer. That same exposed and hot nature of the fort is probably the reason these trees still exist. People needed shade, and because few other trees were capable of growing in such an environment, this remnant natural population was left in place and even allowed to regenerate (perhaps with a bit of assistance from the local inhabitants). Standing

Michael Dosmann at the base of the Algernourne Oak at Fort Monroe.

The Algernourne Oak at Fort Monroe is estimated to be over 450 years old.

in the parade ground, we imagined ourselves dressed in full uniform, performing drills and marching for hours under the hot sun and dry, salty breeze—those trees would be considered sacred! The trees were in remarkably good condition considering their age, size, and the heavy impact of human activities on the site. Many of them showed the marks of time but they were mostly healthy and growing well, a testament to the resilience of southern live oaks.

Tony Aiello stands near a cluster of *Osmanthus americanus* along the namesake Osmanthus Trail at First Landing State Park.

FIRST LANDING

We dedicated the 23rd to surveying the flora of First Landing State Park, which lies on Cape Henry between Norfolk and Virginia Beach. Its current name, changed from Seashore State Park in 1997, acknowledges this site as the location where the Virginia Company first landed in 1607 prior to settling Jamestown. The park covers about 3,000 acres, and comprises eight upland plant community types that range from dune crests to mesic forests (Clampitt 1991). Our initial foray was into the mesic forests where several of our non-oak collecting targets were to be found: devilwood (*Osmanthus americanus*) and swamp bay (*Persea palustris*). Like southern live oak, these two species of shrubs or small trees are near or at their northernmost ranges in Virginia. And, for reasons similar to our quest for hardy southern live oak germplasm, we were anxious to locate and collect from these species.

Finding them was quite easy thanks to our earlier planning conversations with Erik Molleen of the Virginia Department of Conservation and Recreation; the fact that there was an Osmanthus Trail in the park was also helpful. *Osmanthus americanus* specimens were numerous and scattered throughout the understory. They became easy to identify from a distance because their glossy green leaves are arranged oppositely, as with other members of the olive family (Oleaceae). At the Arnold Arboretum, this species has proven to be quite a challenge to cultivate because of cold hardiness issues. One clone, a cultivated lineage from Spring Grove Cemetery in Cincinnati, Ohio, has been reliably hardy in Boston. Likewise a plant at the Morris Arboretum has survived but not thrived since it was received from a local nursery in 1962. Wild-provenance material has long been a target because of the species' botanical and ornamental appeal. Its broadleaved evergreen foliage provides winter interest, and the small, creamy white flowers in spring are a delight to the nose; their mellic scent beckons from great distances. We were able to collect fruits—bright green drupes at this stage—from many trees in the woodland.

Persea palustris also dotted the understory, and, like devilwood, has large, elliptic, evergreen

MIKE HOGAN, HTTPS://FP.AUBURN.EDU/SFWS/SAMUELSON/DENDROLOGY

Devilwood (*Osmanthus americanus*) bears sweetly fragrant flowers in the spring.

COURTESY OF BOBBY HATTAWAY, WWW.DISCOVERLIFE.ORG

Mini-avocados? Immature fruits of *Persea palustris* bear a slight resemblance to their large-fruited relative, the avocado (*Persea americana*).

The ghostly white Indian pipe (*Monotropa uniflora*) blooms above the fallen cones of loblolly pine (*Pinus taeda*).

leaves. However, the leaves are coarser in texture and borne alternately in this member of the laurel family (Lauraceae), and the fruits (also drupes) were an eye-catching purplish blue at this stage. With only a bit of imagination, it is easy to see the kinship to *Persea americana,* the avocado. However, with drupes less than ½ inch long, they wouldn't yield much guacamole.

Many other plant species caught our eyes. Sand hickory (*Carya pallida*) grew in and along the higher ridges. This species was also on our target list, but there were very few fruits to be found; those we did stumble upon were on the ground and of poor quality. While scouring the ground, it was a treat to see Indian pipe (*Monotropa uniflora*), the nodding white flowers and stems appearing like dancing apparitions among the pine cones. Looking up, we noticed many leaves of sourwood (*Oxydendrum arboreum*) at their peak for autumn color, the brilliant reds and oranges echoed in the near-spent needles of bald cypress (*Taxodium distichum*). These bald cypress trees were impressive, conjuring up images of great swamps, and yet we were only a few hundred meters from sand dunes and the ocean (a reminder of how quickly landscapes change). Because the water level was down considerably, their buttressed trunks and knees were exposed to reveal an amazing network of lignified stalagmites. Throughout the woodland landscape, Spanish moss draped across the limbs and branches like overloaded Christmas tree tinsel. As with southern live oak and devilwood, southeast Virginia marks the northern edge of the native range for this rootless member of the pineapple family (Bromeliaceae).

After a brief lunch, we explored the shoreline of First Landing, a strip considerably different than what we saw in the morning. The morning site was lush and diverse, but this sandy strand was quite the opposite. Oaks—primarily

The water table was down considerably at First Landing State Park, exposing the buttressed trunks and knees of the bald cypress (*Taxodium distichum*).

Multistemmed and low branching *Quercus virginiana* at First Landing State Park.

southern live oak plus some bluejack oak (*Q. incana*)—dominated this landscape to create a band of dense vegetation that was pruned by the salt-laden winds into interesting forms and habits. As we had seen with the cultivated plants, the live oak trees were wider than tall (but rarely over 20 feet [6.1 meters] in height) and frequently had multiple stems and a low-branching form. One of the larger trees we found had three stems measuring 12.5, 17, and 21 inches (31.8, 43.2, and 53.3 centimeters) in diameter at 12 inches (30.5 centimeters) above the ground. Despite the stressful environment, trees were healthy and there was noticeable regeneration of young seedlings in the understory, which is always a good sign. Rather than focus on individual trees at this site, we maximized the amount of genetic variation in the collection by gathering acorns from 12 trees. Some trees were so fecund and at perfect ripeness that we could easily shake the branch and scores of the nuts would drop from their caps.

NEXT STEPS

Although the fieldwork is complete, the data are in the databases, and the herbarium specimens are mounted, much work remains ahead of us. Each of our institutions is hard at work germinating the seeds from the various collections made on the trip—twelve separate *Q. virginiana* collections, plus one each of the *Persea*, *Osmanthus*, and *Q.* × *comptoniae*. We plan to try several different methods to successfully coax the oaks into cultivation. For starters, we captured a wide swath of variation during our trip—one never knows just which germinating seedlings from which populations will be the ones to survive. Because young plants are less cold hardy than older ones, we plan to hold some seedlings in containers for a few years before planting them into nurseries. And, because each of our arboreta has microclimates that are warmer than our nursery areas, we also plan to plant some young plants directly into those microclimates, skipping the nursery altogether. For marginal species such as these, success often is achieved by those who hedge their bets.

Southern live oaks and sea grasses growing along the dunes of First Landing State Park.

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Mark Catesby: Pioneering Naturalist, Artist, and Horticulturist

David Yih

This April marks the 301st anniversary of naturalist Mark Catesby's arrival in Williamsburg, Virginia, to begin the first of two exploratory sojourns he would make in the American colonies. A dabbler in watercolors from a family of provincial English lawyers, Catesby was twenty-nine when he stepped off the ship to begin the adventure that would determine the course of his life and culminate in his monumental work on North American flora and fauna, *The Natural History of Carolina, Florida, and the Bahama Islands.* The lavishly illustrated work would be hailed in the *Philosophical Transactions* of the Royal Society of London as "the most magnificent work … since the art of printing has been discovered" (Mortimer 1748). It would stand as a benchmark in American natural history throughout the eighteenth century and be deemed "the most splendid of its kind that England had ever produced" (Pulteney 1790).

Though little documentation of Catesby's early life exists, it is generally supposed that his interest in the natural world had been stimulated by his uncle Nicholas Jekyll, an avid gardener who introduced the young man to John Ray, "the foremost English naturalist of the late seventeenth century … whose systems would dominate English natural history until the adoption of Linnaean classification" (Frick 1974). The best glimpse into Catesby's preoccupations as he first arrived in America to visit his sister's family and have a look around comes in his own words:

> "… my Curiosity was such, that not being content with contemplating the Products of our own Country, I soon imbibed a passionate Desire of viewing as well the Animal as Vegetable Productions in their Native Countries; which were Strangers to England. Virginia was the Place (I having Relations there) suited most with my Convenience to go to, where I arriv'd the 23d. of April 1712. I thought then so little of prosecuting a Design of the Nature of this Work, that in the Seven Years I resided in that Country, (I am ashamed to own it) I chiefly gratified my Inclination in observing and admiring the various Productions of those Countries, only sending from thence some dried Specimens of Plants and some of the most Specious of them in Tubs of Earth, at the Request of some curious Friends …" (Catesby 1731)

Perhaps Catesby could afford to be a bit modest by the time he wrote these prefatory words of his celebrated magnum opus. In reality, when he returned to England after seven years in the colonies, he "brought with him an extensive knowledge of New World flora and fauna as well as an impressive cache of drawings of animals and plants never before seen by English naturalists" (Meyers and Pritchard 1998). These were sufficient to attract the interest of the eminent English botanist William Sherard, who happened to be in the process of organizing sponsors to send a naturalist across the Atlantic to explore and document the living wonders of America, especially those that might have scientific, economic, ornamental, or curative value. Whom to send on this mission was an issue yet to be resolved. But an ability to render accurate images of the new finds would be a significant qualification. Impressed by Catesby's work, Sherard wrote to an acquaintance, "He designs and paints in water colours to perfection."

Catesby got the job, and with the support of a dozen backers—including a number of aristocrats as well as the President and several members of the Royal Society—set out on his second journey, arriving in Charleston, South Carolina, in 1722. With the funds and trust that were now invested in him, he threw himself into

The Mock-Bird and Dogwood Tree
Northern mockingbird (*Mimus polyglottos*) and flowering dogwood (*Cornus florida*)

A Note About the Images

THE IMAGES in this article were scanned from the Arnold Arboretum's copy of Catesby's *Natural History of Carolina, Florida, and the Bahama Islands.* Our copy is the revised edition published in 1754. It was purchased for $50.00 in February 1912 with funds provided by Francis Skinner, a friend and neighbor of Charles Sprague Sargent. This copy had previously been in the library of Venetian botanist Francesco Rizzo Patarol.

Catesby's book used Latin polynomials (multi-word descriptive phrases) to identify the plants and animals, the accepted practice before Linnaeus's system of binomial plant names became widely established. Linnaean binomials were added to the third edition (1771), and over the years researchers have provided more accurate identification and nomenclature. For the images that appear in this article, the first line of each caption gives the common names (or the first part of the Latin polynomial if listed only that way) as they appear in Catesby. The second line provides the modern common and scientific names from Reveal (2012).

his work, resolving never to visit the same area twice during the same season. The frequent clamoring of his impatient backers for specimens sometimes hampered his efforts at what he saw as the main thing to be accomplished: an illustrated record of the plants and wildlife of America. But he persevered and for four years ranged from coastal plains to Appalachians and from the Carolinas south through Georgia, Florida, and the Bahamas, collecting, documenting, and painting as he went.

Upon his return to England in 1726, Catesby took a job as a nursery horticulturist and began work on the great book he envisioned. The project would take more than twenty years to complete. And he would have to publish it himself. In a practice common at the time, Catesby solicited subscribers by issuing a prospectus describing the proposed publication and his qualifications for undertaking it. Subscribers would make advance payments, and these would help defray the costs of producing the books. Catesby gave persuasive evidence of the worthiness of his project by listing in the prospectus the names of the twelve eminent men who had sponsored his second trip and by publicly exhibiting the drawings and watercolors he had brought with him from the colonies. Ultimately, 155 persons and institutions signed on, enough to set the project in motion.

In order for the illustrations to be printed, they would have to be engraved into copper

The Blue Bird and *Smilax non spinosa, humilis*
Eastern bluebird (*Sialia sialis*) and sarsaparilla vine (*Smilax pumila*)

The Globe-Fish and *Cornus, foliis Salicis Laureae acuminatis* (upper) and *Phaseolus minor lactescens flore purpureo* (lower)

Checkered pufferfish (*Sphoeroides testudineus*), lancewood (*Nectandra coriacea*), and red milk-pea (*Galactia rudolphioides*)

The Pigeon of Passage and the Red Oak
Passenger pigeon (*Ectopistes migratorius*) and turkey oak (*Quercus laevis*)

plates. Catesby had hoped to have the work done by the expert engravers of Amsterdam or Paris, but given the number of plates involved—220 would grace the finished work—the expense proved prohibitive. Undeterred, he studied the technique of etching with Joseph Goupy, a French printmaker and art instructor then living in England, and proceeded to etch all of the plates himself. He published the work in installments of twenty plates with accompanying bilingual English–French text. Sherard supplied the Latin polynomials, which were the brief descriptive phrases used as species names before Linnaeus' binomial (genus + specific epithet) system came into general use. Upon the completion of each new segment, Catesby presented it to the Royal Society, which was, itself, a subscriber. When he presented the fifth installment in 1732, the one hundred plates that would comprise the first volume of the two-volume work were finished. Within a few months, Catesby was formally nominated and duly elected a Fellow of the Royal Society.

The publication of Catesby's *Natural History,* the first illustrated account of North American flora and fauna, was ultimately completed in 1747 with the addition of the twenty-plate appendix to the second volume. (The title page of the first edition gives the publication date as 1731, so citations often indicate that year rather than 1747.) The first volume had been dedicated to the wife of England's King George II, Queen Caroline, for whom Carolina was named. Queen Caroline having now died, Catesby dedicated Volume II to another avid gardener and patroness, Princess Augusta, wife of Frederick, Prince of Wales. The gardens at the couple's country retreat would later form the basis of the Royal Botanic Gardens at Kew, founded in 1760. Catesby himself survived the completion of his *Natural History* by only two years. A revised edition was published posthumously, in 1754, and a third edition, providing Linnaean binomials for the species, came out in 1771.

As set forth on its title page, the *Natural History* presents examples of *"… Birds, Beasts, Fishes, Insects, and Plants: Particularly the Forest-Trees, Shrubs, and Other Plants, Not Hitherto Described, or Very Incorrectly Figured by Authors …"* The first known depictions of a succession of eels, butterflies, and frogs leap, flutter, and writhe from the pages, together with snakes of all stripes and birds of all feathers. The ghost of the passenger pigeon looks out from its page. The species was still so numerous when Catesby encountered it that flocks would "break down the limbs of Oaks with their weight" (they were prodigious consumers of acorns, he notes) "and leave their Dung some Inches thick under the Trees they roost on." (Catesby 1731) Catesby's 111 bird images have led to a perception of him as a kind of overshadowed precursor of Audubon, yet the bulk of what is portrayed in the work belongs to the plant kingdom: 171 species. Richard Howard (director of the Arnold Arboretum from 1954 to 1977) and George Staples were able to

The Cacao Tree
Cacao (*Theobroma cacao*)

match modern scientific names to all but two species (Howard and Staples 1983). They also noted that "Catesby's plates appear to be the types of twenty-five recognized [plant] taxa, of which twenty-one were described by Linnaeus and four by subsequent authors." (A "type" is one particular exemplar that embodies the defining characteristics of a taxon and is permanently associated with it; in botany, a type may consist of either an herbarium specimen or an illustration.)

Specimens of several taxa on Catesby's type list currently grow in the Arnold Arboretum's collections, including pawpaw (*Asimina triloba*), cucumbertree magnolia (*Magnolia acuminata*), umbrella magnolia (*Magnolia tripetala*), sourwood (*Oxydendrum arboreum*), blackjack oak (*Quercus marilandica*), and water tupelo (*Nyssa aquatica*). Though not cold-hardy enough to be grown in New England, another plant having a Catesby illustration as its type deserves mention: the cacao tree (*Theobroma cacao*), whose seeds are the source of chocolate.

As if attempting an accounting of the flora and fauna of a large swath of the continent were not enough, Catesby includes in the *Natural History* a lengthy essay, "An Account of Carolina and the Bahama Islands," in which he discusses the region's climate, soils, habitats, hydrology and geology—including notable fossil finds—as well as Native American culture. He also enumerates the crops grown in the colonial southeast, assessing their suitability and economic potential there, and provides extensively annotated lists of many wild species not illustrated. For good measure, Catesby records recipes for making caviar and pickled sturgeon and describes the process of making tar from pine trees.

Later critics have found flaws in Catesby's work. He sometimes interpreted the differing appearances of juvenile and adult birds as representing members of different species. And though his depictions were broadly accurate, they lacked accuracy in finer details. The work of G. D. Ehret, the botanical illustrator who contributed three illustrations to the *Natural History,* shows a greater attention to details such as venation, as compared with Catesby's relatively stylized renditions. In addition, some inaccuracies resulted from the direct transfer of drawings onto the copper plates. Because printing reverses the image engraved on the plate, creating a mirror image,

The Painted Finch and the Loblolly Tree
Painted bunting (*Passerina ciris*) and loblolly bay (*Gordonia lasianthus*)

The Blue Gross-beak and the Sweet Flowering Bay
Blue grosbeak (*Passerina caerulea*) and sweetbay magnolia (*Magnolia virginiana*)

the direction of twist shown in the twining of Catesby's sweet potato plant (*Ipomoea batatas*) is incorrect. Catesby himself recognized that his artistic skills were limited by his lack of expertise in perspective but felt that his flat depictions were sufficient for the purpose of delineating species.

In time, his work was superseded by the achievements of later generations, and Catesby's renown faded. "After the American Revolution, interest in Catesby's work, as with most things American, waned in England. And as the scientific community became increasingly specialized,... Catesby's generalist approach fell into disfavor. By the time John James Audubon set off to paint in South Carolina nearly a century later, Catesby had been almost forgotten." (Amacker)

In recent decades, however, a new appreciation of Catesby's contribution has emerged. With the perspective of two-and-a-half centuries, it has become clear that Catesby's work was innovative and ahead of its time. He broke from the stilted bird profiles typical of the times to include dynamic images of birds in motion. The bald eagle in full swoop, bearing down upon its prey in the very first plate is an example. He was the first to depict birds against botanical backgrounds. More importantly, in choosing these backgrounds, he made a conscious effort to depict ecological relationships, frequently showing birds with the plants on which they feed or in which they nest. His texts go beyond describing morphology to reveal behavioral and ecological characteristics. In the case of birds, he often commented on aspects of nest-building, feeding, and migratory behaviors. He authored the first scientific paper (Catesby 1746-7) to accurately address the phenomenon of bird migration (earlier theories had birds hibernating in caves or under water during the winter months). For these reasons, and in consideration of the many new bird species he brought to light, Catesby has been called the founder of American ornithology (Frick 1974).

The Blueish Green Snake and *Frutex baccifer, verticillatus*
Rough green snake (*Opheodrys aestivus*) and American beautyberry (*Callicarpa americana*)

Apart from his contributions to natural history, Catesby, throughout his career, maintained an active presence in transatlantic horticultural affairs, participating not only in the importing of interesting American plants into Europe, but in the adoption of useful exotic crops in the colonies, and the transfer of plants among the colonies. His last work, the *Hortus Britanno-Americanus,* published posthumously in 1763, became part of a movement embraced by British gardeners who planted "American gardens"—naturalistic "wilderness" plantings designed to evoke, albeit in a carefully controlled manner, the wildness of the American continent. "Catesby himself … asserted that, in the half-century in which he was active, more plants were imported into England from the British colonies in North America than during the previous one thousand years from all other parts of the world." (O'Malley 1998)

The Yellow Breasted Chat and *Solanum triphyllon flore hexapetalo*
Yellow-breasted chat (*Icteria virens*) and spotted wakerobin (*Trillium maculatum*)

In the course of his transatlantic horticultural activities, Catesby may have had a hand in the naming of a genus with which the Arnold Arboretum has a special relationship, *Stewartia.* (The *Stewartia* collection is one of six that the Arboretum curates as a member of the North American Plant Collections Consortium, with the goal of broad acquisition and long-term preservation of *Stewartia* germplasm.) Upon receiving specimens of a new shrub from a correspondent in Virginia, Catesby planted them at the nursery where he worked in Fulham, England. As Spongberg and Fordham (1975) relate, "The plants flowered in May of 1742, and it is suspected that Catesby, recognizing their ornamental value and botanical interest, gave plants of the new shrub to John Stuart, the third Earl of Bute, for the botanical garden he was helping to establish at Kew." Subsequently, Linnaeus named the genus in honor of Stuart in 1746.

It is a telling testament to the importance of Catesby's work that scholars and scientists continued to acknowledge his pioneering efforts

Steuartia

Silky camellia (*Stewartia malacodendron*) [Ed. note: Though he named the genus in honor of John Stuart, Linnaeus spelled it as *Stewartia.* This is still the generally accepted spelling, though some taxonomists spell it as *Stuartia.* Catesby's spelling seems to split the difference.]

long after his death. In his *Species Plantarum* (1753), Linnaeus cited Catesby ninety-five times (Ewan 1974). Thomas Jefferson cited Catesby in the table of North American birds he included in his *Notes on the State of Virginia* (1785) to contest a French naturalist's assertion that American species lacked variety. Lewis and Clark studied the *Natural History* in preparation for their explorations, as did Alexander von Humboldt. And Catesby has been immortalized in the scientific names of many American organisms. Our bullfrog was named *Rana catesbeiana,* in 1802. Catesby has four reptiles named for him and a number of plants, including (with the naming botanist's name appended) *Lilium catesbaei* Walter, *Gentiana catesbaei* Walter, *Quercus catesbaei* Michaux (a synonym of *Q. laevis*), *Clematis catesbyana* Pursh, *Trillium catesbaei* Elliott, and *Leucothoë catesbaei* (Walter) A. Gray (a synonym of *L. axillaris*).

A few genera also bear Catesby's name. The Dutch botanist Gronovius had already named the lily-thorn genus, *Catesbaea,* for Catesby during his lifetime. In 1968, the monospecific genus *Catesbya* was erected by J. E. Böhlke and D. G. Smith for *Catesbya pseudomuraena,* an eel inhabiting the reefs of the Bahamas. In naming the new genus the authors explicitly paid tribute to "Mark Catesby, whose [work] marks the beginning of our knowledge of Bahaman fishes" (Böhlke & Smith 1968).

In the end, Catesby's artwork had a new triumph. Purchased by George III in 1768, the original watercolors and drawings that were the basis for Catesby's *Natural History* etchings were placed into books and shelved in the Royal Library at Windsor Castle. There they remained, all but forgotten, for well over two centuries. In 1997, they were at last unbound for conservation work. A new book of reproductions was published, and selections were assembled into two international traveling exhibitions. One went to the United States, where it was displayed at a succession of four museums before finishing its tour back in the United Kingdom at the Queen's Gallery in London; the other visited four sites in Japan. For the first time since the 1720s, the public could view and appreciate the original images Catesby had trekked through the wilds of America to bring home.

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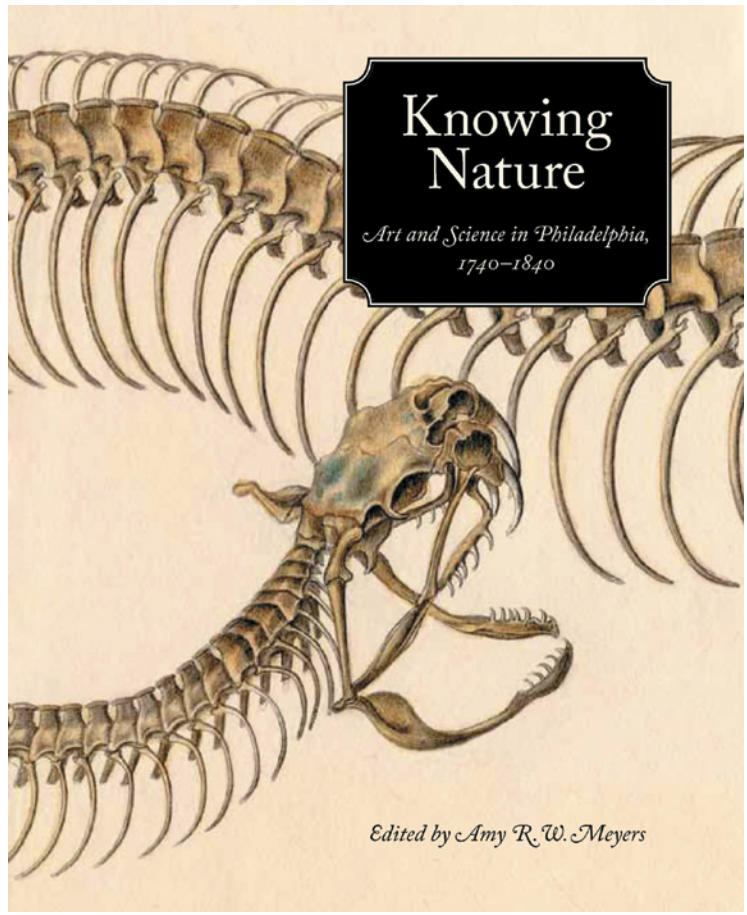
Book Review: *Knowing Nature: Art and Science in Philadelphia, 1740–1840*

Peter Del Tredici

Knowing Nature: Art and Science in Philadelphia, 1740–1840
Edited by Amy R. W. Meyers with the assistance of Lisa L. Ford
New Haven: Yale University Press, 2012. 417 pages.
ISBN 978-0-300-1104-0



It's hard to fully appreciate this high quality, large format (10 by 12 inches) book without actually picking it up and thumbing through its stunningly beautiful pages. It is at once a graphic and an intellectual tour de force that examines the passion for the arts, sciences, and culture that characterized Britain and America during the dynamic years from 1740 to 1840, immediately before and after the American Revolution. The thirteen historians who contributed articles to the book come from a variety of backgrounds and specialties, but all are experts in their fields and share a deep passion for their subjects. Together they have created a portrait of this time period that overwhelms the reader with many exquisite eighteenth-century illustrations of plants, animals, human anatomy, architecture, and decorative arts.

Perhaps because so many of the contributors are art historians or curators (the editor is the Director of the Yale Center for British Art), the book has the look and feel of a museum exhibition. More than anything else, the book presents the art and artifacts of the era in their historical context such that their deeper social meaning becomes visible. Nowhere is this more apparent than in the chapter by Alexander Nemerov on "The Rattlesnake," which discusses a spectacularly beautiful illustration once thought to have been drawn by Benjamin Smith Barton, but now attributed to the British-born architect Benjamin Henry Latrobe. Not only does Nemerov carefully dissect the drawing and relate it to Latrobe's architectural work but he also explores the symbolic significance of the rattlesnake during the period of the American Revolution.

A common thread that runs through the book is the life and work of William Bartram, as seen most clearly in the articles by Joel Fry and Amy Meyers who, taken together, create a masterful portrait of the scientific, horticultural, and artistic context in which he worked. More than any other historical figures, the Bartrams (father John and son William) personify the complex and highly fruitful interchange between Europe and North America both before and after the Revolution. I was particularly fascinated by the

One of the images of ginseng in the book is *The Whip-Poor-Will and the Ginseng, or Ninsin of the Chinese* from Catesby's *Natural History of Carolina, Florida, and the Bahama Islands.*

story of John Bartram's involvement in the discovery of ginseng in Pennsylvania (1739) and his efforts to collect plants for his patron, Peter Collinson, who was interested in establishing a business exporting American ginseng from England to China. While I have read about this story before, the six beautiful images of ginseng (including a botanical specimen collected by Bartram) that illustrate Janice Neri's chapter on the China trade give this version a vitality that text alone does not provide.

Mark Laird's chapter on "The American Connection in Georgian Pleasure Grounds" traces how the interest in and importation of North American plants and animals into England changed the nature of designed English landscapes. In a similar vein, I found Lisa Ford's chapter about François-André Michaux's *North American Sylva* particularly enlightening. She not only discusses the history of this incredibly beautiful and scientifically seminal work, but also the story behind its creation, including a copy of the questionnaire that Michaux used when gathering information about the local uses and distributions of native trees. Again, her discussion of the larger rationale for producing such a lavishly illustrated book, namely that Napoleonic France was anxious to replant its forests after centuries of unchecked exploitation, puts the focus not just on the object itself but its historical context. Alicia Weisberg-Roberts contributes a chapter on the relationship between eighteenth-century textile design and Philadelphia natural history, and James Green deftly covers the salient details in the important transition between hand coloring and color printing in natural history books.

The second to last chapter of the book covers the pictorial history of the Lewis and Clark expedition and the role played by eminent citizens of Philadelphia, including Benjamin Smith Barton, Benjamin Rush, Caspar Wistar and Charles Willson Peale, whose natural history museum housed many of the animal skins and skeletons Lewis and Clark collected on their journey. The last chapter of the book is devoted to an analysis of how the work of Philadelphia naturalist John Goodman (author of *Rambles of a Naturalist*) and *Birds of America* creator John James Audubon "democratized" the subject of natural history, making it accessible to a much wider audience. In short, this wonderful book puts the panorama of early American natural history studies into its proper social and historical context in a most beautiful and elegant way.

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Betula dahurica: A Special Birch Tree

Hugh McAllister

In the United Kingdom, *Betula dahurica* has a reputation for not making a well-shaped tree, as it often suffers repeated dieback and poor growth because of late spring frosts and inadequate summer heat. One specimen in the Arnold Arboretum (overhanging the road on Bussey Hill) shows the typical "witches' broom" growths caused by such repeated dieback, but most trees of *B. dahurica* in the Arboretum have made good specimens. Particularly noteworthy is a tree of Japanese origin (accession 1015-80-A) just off Conifer Path near the bamboo collection. Dahurian birch is noted for its peeling, papery bark (similar to river birch, *B. nigra*) and this specimen has particularly attractive shaggy curls that have a redder color on their inner surface than some other Arboretum specimens. The color of the inner surface contrasts nicely with the creamy white of the outer surface of the curls and the unpeeled sections of bark on the branches.

Betula dahurica is native to China, Japan, Korea, eastern Mongolia, and far eastern Russia. Accession 1015-80-A is of special interest since *B. dahurica* is endangered in Japan, being known primarily from a small population near Nobeyama in Nagano Prefecture in the central part of the main island of Honshu (where this accession was collected). There is another small population in the northern island of Hokkaido and one on Iturup in the Kurile Islands, which were Japanese before being occupied by Russia at the end of World War II. Of genetic interest, these offshore island populations are hexaploid (6 times the base number for birches of x=14) with a chromosome number of 2n=84, whereas the extensive populations on the Asiatic mainland all appear to be octoploid with 2n=112. This means that the island populations are unlikely to interbreed freely with the mainland populations, are genetically distinct, and, if they can be recognized by their appearance, should be named as a distinct species.

Three cuttings from the tree in the Arboretum have been rooted and are now growing in the nursery. The only other known trees from the Nobeyama provenance in cultivation are a single tree at Dawyck, a satellite garden of the Royal Botanic Garden Edinburgh in southern Scotland, and six trees at Ness Gardens, the University of Liverpool Botanic Gardens near Chester in northwest England. Trees from this provenance grow far better in the United Kingdom than any from continental Asia, presumably because of the greater similarity of our climate to the maritime climate of Japan.

Since the Nobeyama trees are genetically distinct and rare in the wild, they are clearly of conservation significance and efforts should be made to have breeding populations for seed production in cultivation. Most species of birch are self-incompatible (self-sterile), so at least two different seedling trees are needed for seed production. Fortunately we have this at Ness and, despite the large number of other birch species in the surrounding garden, seedlings from the cultivated trees seem to be mostly coming true (i.e., are not hybrids with other species).

Accession 1015-80-A is producing some viable seeds, so it will be interesting to sow this and see what the seedlings are. If the parent tree is totally self-incompatible then all the seedlings will be hybrids. No known hybrids of *B. dahurica* have ever been reported, and certainly no hybrids of the Nobeyama provenance, so, if we can identify what the other parent(s) might have been, it will tell us what other species *B. dahurica* can hybridize with. Any such hybrids could be of horticultural interest since *B. dahurica* may be resistant to bronze birch borer. Alternatively, accession 1015-80-A could have a limited degree of self-compatibility (resulting in a low percentage of viable seeds) and at least some of the seedlings could be the result of self-fertilization. This could result in some dwarf or other abnormal growth forms as a result of inbreeding depression—this is the probable mode of origin of many dwarf conifers. No doubt this species, and the Japanese provenance in particular, will continue to be studied, conserved, and propagated at the Arnold Arboretum, Ness Gardens, and other botanical institutions.

Hugh McAllister is an honorary lecturer at the University of Liverpool and was recently a Sargent Award visiting scholar at the Arnold Arboretum.