



*The* **ARNOLD**  
**ARBORETUM**  
of HARVARD UNIVERSITY



2012–2014 TRIENNIAL REPORT



## The Arnold Arboretum of Harvard University

**F**ounded in 1872 as the first public arboretum in North America, the Arnold Arboretum of Harvard University is a leading center for the study of plants and biodiversity. Its 281-acre landscape holds one of the most comprehensive and best documented collections of temperate woody plants in the world, with particular emphasis on the flora of the eastern United States and eastern Asia. The living collection supports research through comprehensive curatorial documentation, herbaria containing more than 1.4 million specimens, extensive library and archival holdings, and a state-of-the-art research center that opened in 2011. A resource for both scholarship and public education, the Arboretum offers programs for people of all ages to promote the understanding and appreciation of plants and their essential value to humankind. Open free every day, this jewel in the Emerald Necklace park system welcomes over 250,000 visitors annually and is among the most beloved open spaces in Boston.

"The enjoyment of scenery employs the mind without fatigue and yet exercises it, tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration of the whole system." —**Frederick Law Olmsted, *Yosemite and the Mariposa Grove: A Preliminary Report, 1865***

"We show in healthy participants that a brief nature experience, a 90-min walk in a natural setting, decreases both self-reported rumination and neural activity in the subgenual prefrontal cortex (sgPFC), whereas a 90-min walk in an urban setting has no such effects on self-reported rumination or neural activity." —**Gregory Bratman et al., *Nature experience reduces rumination and subgenual prefrontal cortex activation, Proceedings of the National Academy of Sciences, July 14, 2015.***

**A**s stated exactly 150 years ago by the famed designer of the Arnold Arboretum and Boston's Emerald Necklace, and more recently (and considerably less poetically) in the one of the most eminent scientific journals, there is something utterly transformative about connecting with the natural world. From refreshing the psyche to revealing how plants are reponding to our changing climate, the Arnold Arboretum demonstrates on a daily basis its remarkable capacity to inspire curiosity, open eyes and minds, and touch lives.

This triennial report provides brief snapshots of the people, projects, and priorities that are shaping this remarkable institution as we approach our sesquicentennial as a living museum of natural history. When I became director in 2011, the yet-to-be opened Weld Hill Research Building held great promise for the future of both the Arboretum and botanical research at Harvard and beyond. Over the period covered in this report (2012–14), Weld Hill has truly blossomed, hosting three Harvard professors, research associates, postdocs, and graduate students. Their research programs mingle with hosts of undergraduate students, research award recipients, guest investigators, and visiting scientists in our laboratories. All of this contributes to championing the Arboretum's mission as a center for plant and environmental study and as a locus for higher learning and professional development.

This pursuit of innovation and excellence extends necessarily to the horticultural sciences as well, by virtue of what is required to properly develop and steward our valued collections as the foundation of all we do. We continue to invest in our future as a landmark public garden through exploration, rigorous curation, horticultural expertise, and collaborative efforts for plant conservation. This means providing exceptional care to our 15,000 accessioned plants, each revealing beauty and insight if only we take the time to observe and learn from nature. If you have never seen a birch infructescence shatter, or wandered through our *Aesculus* collection, or quietly strolled through the conifers when it snows, then your Arboretum "bucket list" is not yet complete.

Of course none of this would be possible or even imaginable without the dedication and Herculean efforts of our outstanding staff and volunteers, whose devotion and commitment inspire me every day. I also owe tremendous gratitude to all of you who visit, enjoy, learn from, and support the Arnold Arboretum—your participation is critical to making this such a vibrant and dynamic place. We have so much more to discover and accomplish together, beneath and among some of the most fascinating and consequential plants on Earth.

—William (Ned) Friedman  
Director & Arnold Professor of Organismic and Evolutionary Biology

# Biodiversity and Discovery



Chinese hemlock (*Tsuga chinensis*) has been grown and tested extensively at the Arnold Arboretum since the discovery of hemlock wooly adelgid on Hemlock Hill more than a decade ago. Cold hardy and relatively fast growing, *T. chinensis* offers a vigorous and adelgid-resistant alternative to native hemlocks in managed landscapes.

*The Arnold Arboretum helps scientists foster both independent and collaborative work along new paths of inquiry by sharing its world-renowned living collection, herbarium, plant records, library and archives, greenhouse and laboratories, and the expertise of its staff.*

As a center for the preservation and study of plant biodiversity, the Arnold Arboretum strives to serve as a nexus for scientists to integrate their approaches and make progress towards a more unified understanding of plants and their full complexity. Additionally, the Arboretum actively promotes scholarship that is derived from the opportunities presented by a world class collection of living organisms lying in direct proximity to state of the art research facilities.

# Revealing the Invisible World of Trees

## *Arboretum Ginkgos Facilitate Pioneering Biome Study*

A unique relict of evolution, *Ginkgo biloba* has long engaged and fascinated plant scientists, playing a pivotal role in the research careers of both Director William (Ned) Friedman and Senior Research Scientist Emeritus Peter Del Tredici. While the tree's reproductive biology, evolutionary history, and highly unusual morphology have been well studied, we know little about how ginkgo interacts with its environment. To investigate the diversity of microorganisms that live on ginkgo, three wild-collected specimens growing near the Arboretum's Bussey Street Gate were studied beginning in 2012 to construct the first-ever microbiome of a tree.

To discover the types and numbers of organisms that live on trees and the role they play in plant biology, Ned and Peter collaborated with colleagues from the University of Colorado to sample and analyze the bacterial associates living on the above-ground surfaces of Arboretum ginkgos.

By examining over 100 locations per tree, such as up and down the tree as well as north to south in the landscape, the project aims to shed light on the trees' microbial diversity and whether these communities varied according to their location. They found that there were distinct microbial communities that, while variable, were also predictable of the location. For example, the microbial community of bark was distinct from and more diverse than the leaf community, and older bark displayed increased microbial diversity compared to younger bark. As the study continues, subsequent comparisons with wild specimens in China and with other tree species will show whether the composition of microbial communities is dependent on the taxonomy or geographic location of the host.

This work benefits from the Arboretum's historical strength in studying and documenting the



Jon Hetman

Head Arborist John DelRosso (*far right*) operates the Arboretum's bucket truck to assist the collection of microbe samples in *Ginkgo biloba* #1223-89\*A by scientists from the Fierer Lab at the University of Colorado.

flora of eastern Asia, and demonstrates an increasing interest in understanding the relationship between trees and their environment. Because this type of research is so pioneering, a great deal may be discovered, including never-before described species of woody plant symbionts. In continuing to build capacity for monitoring conditions in the landscape, the Arboretum is fostering new applications for the living collections to support research across a range of the ecological and environmental sciences.

Leff JW, Del Tredici P, Friedman WE, Fierer N. 2015. Spatial structuring of bacterial communities within individual *Ginkgo biloba* trees. *Environmental Microbiology*. 17: 2352-2361. First published online in December 2014.

# Weld Hill Welcomes New Faculty

## *Arboretum Fellowships and Awards Create Opportunities and Scholarship*

The winter 2011 opening of the Weld Hill Research Building represented a watershed opportunity for the Arnold Arboretum to expand its scientific program and to consolidate its footprint from various parts of the Cambridge campus to one location—one within close proximity to the Arboretum landscape and collections in Jamaica Plain. Part of this effort involved a new commitment from Harvard University and specifically the Department of Organismic and Evolutionary Biology, which helped underwrite Weld Hill's research greenhouses and teaching labs and approved a search for new faculty to be stationed at the Arboretum. In January 2014, the Arboretum welcomed two assistant professors to teach and pursue research programs at Weld Hill as joint faculty with OEB—Drs. Robin Hopkins and Elizabeth Wolkovich. Their arrival marks a significant step in expanding the Arboretum's capacity for scholarship, its participation in educating Harvard undergraduates, and its impact in the botanical and environmental sciences.

Assistant Professor Robin Hopkins studies the process of speciation in natural populations, a critical question in the field of evolutionary biology. During her doctoral studies at Duke, Robin applied modern molecular techniques to study flower color variation in *Phlox*, and was the first to identify the genetic basis of reinforcement in a natural system. Her analyses and garden experiments with the genus *Phlox* provide further evidence of how plants diversify and the role that pollinator behavior can play in the creation of new species. At the Arboretum, Robin continues these investigations, with a growing focus on reproductive incompatibility between emerging



Jon Hetman

Assistant Professor Robin Hopkins observes flowers of *Phlox drummondii* in the research greenhouses at Weld Hill.

species or distinct populations of the same species, and theoretical work aimed at estimating the key evolutionary forces at work in the system.

Assistant Professor Elizabeth Wolkovich conducts field investigations to track the influence of climate change on plant communities. Integrating the disciplines of ecology, climatology, and phenology—the timing of life cycle events—Lizzie explores how plants have responded and may continue to respond to global warming. To address these issues, she has amassed a flowering time dataset for more than 14,000 plant species, including more than 30 years of data for approximately 2,000 of those species. Contrary to expectations, Lizzie has discovered that experimental studies of climate change greatly under-predict observed responses in

natural environments. Most recently, she has shown that numerous temperate plant species previously thought to be unresponsive to climate change are in fact quite dynamic in their responses. Such results



Jon Hetman

Assistant Professor Lizzie Wolkovich examining fruits of Chinese bittersweet (*Celastrus orbiculatus*) at the Case Estates in Weston, Massachusetts.

are liable to be hugely important for developing better predictive models of how plants will respond to future change.

Increasing coordination of research and educational activities between Harvard University and the Arboretum will expand and enhance the use of Arboretum's living collections, herbaria, and library and archives. The research programs of Arboretum faculty—which also includes the laboratory of Director William (Ned) Friedman, Arnold Professor of Organismic and Evolutionary Biology—will significantly increase scholarship on plants at Harvard. With the partnership of Harvard OEB, departmental faculty, and graduate and undergraduate students, the Arboretum will continue to build even more substantive programs for outreach that share Arboretum collections and state-of-the-art science with the public.

## New Teaching Labs Opened

For students and faculty interested in plant biodiversity in all of its manifestations, the Weld Hill Research Building at the Arboretum provides advanced facilities—along with access to a living collection of more than 15,000 plants described by extensive cutatorial documentation—to support scientific discovery and education through coursework, laboratory investigations, and collections-based fieldwork. As part of this increased engagement, the Arboretum and the Faculty of Arts and Sciences at Harvard University partnered to establish new teaching laboratories at Weld Hill.

Suitable for digital microscopy, physiology, ecology, and molecular biology, Weld Hill's teaching labs are among the most advanced facilities available in the world for student investigations in the botanical sciences. Harvard classes meeting at Weld Hill may also incorporate field work in the Arboretum landscape, as well as connect students to associated collections in the Arboretum's herbarium and Horticultural Library. Several Harvard courses with field and/or laboratory components have taken flight at Weld Hill since the opening of the teaching labs in summer 2013, including Plant Development and Differentiation, Science and the Human Past, and Getting to Know Charles Darwin.

The teaching labs provide additional support for student investigations through access to Weld Hill's greenhouses and reach-in and walk-in plant growth chambers. Two of the growth chambers are prioritized for classroom use, and staff continue to refine and expand a teaching collection of representative plants at Weld Hill suitable for diverse course applications. Additionally, information technology staff are developing an associated database that will allow researchers using the growth facilities to track data on plants under investigation and enable reference searches of the teaching collection.

# Opening Doors, Sharing Knowledge

## *Arboretum Fellowships and Awards Create Opportunities and Scholarship*

**T**hrough a strong legacy of past and present philanthropy, the Arnold Arboretum offers a number of competitive fellowships and research awards annually to scientist from around the world at various stages of their careers. With this funding and the collaborative support provided by Arboretum scientists and staff, researchers gain unique opportunities to pursue both independent and collaborative research using the Arboretum's living collections, herbarium resources, library and archives, and Weld Hill laboratories and greenhouses. Over the past three years, the Arboretum has funded research by the following awardees, each drawing on distinct strengths of the Arboretum's living, herbarium, and library/archival collections.

### LIST OF RESEARCH FELLOWSHIP AWARDEES: 2012-2014

#### **Katherine H. Putnam Fellowships in Plant Science**

*Putnam Fellows are independent post-doctoral positions. As staff of the Arboretum, they conduct basic and applied research in the plant sciences utilizing the collections of the Arnold Arboretum.*

♦ **2011–13 Cary Pirone, PhD**

Pollination drops proteins and pollen-ovule interactions in three diverse conifers

♦ **2012–14 Guangyou Hao, PhD**

The paradox of being a deciduous conifer: Xylem hydraulics of softwood species

♦ **2013 Stacey Leicht Young, PhD**

Temperate lianas—Do traits predict their success in northern temperate landscapes?

♦ **2014 Ailene Ettinger, PhD**

Future predictions from current plant collections: Exploiting the novel climates of arboreta to understand tree responses to climate change

♦ **2014 Jessica Savage, PhD**

Vascular constraints on Flower development: Explaining the physiological basis of early spring floral displays

#### **Ashton Award for Student Research**

*The Ashton Award for Student Research supports investigations by graduate and advanced undergraduates working on Asian tropical forest biology.*

♦ **2012 Ha Thanh Nguyen, PhD student, Boston University**

Characterizations of the carbon balance and vegetation dynamics in peat swamp forests in northwestern Borneo

♦ **2014 Janice Chan, PhD student, Harvard University**

The function and maintenance of plant functional diversity across a range of Asian tropical forest ecosystems

#### **Cunin-Sigal Research Award**

*The Cunin/Sigal Award supports investigations by graduate and advanced undergraduate students engaged in botanical research.*

♦ **2014 Bryan Connolly, PhD candidate, University of Connecticut**

Increasing diversity in the improved *Aronia* gene pool



### The James R. Jewett Prize

The Jewett Prize is awarded to researchers studying the biology of flowers and/or fruits.

- ♦ 2012 **Jorge Lora, Post-doctoral Fellow, Experimental Research Stations-CSIC, Spain**

Study of INNER NO OUTER (INO) gene in temperate fruit trees of the Rosaceae

- ♦ 2012 **Bharti Sharma, Post-doctoral Fellow, Harvard University**

Developmental and molecular characterization of petal development in Berberidaceae

- ♦ 2014 **Ling Guo, Curator, Beijing Botanic Garden**

Improving and adding to a database of research on ornamental apples (*Malus* spp.)

### Sargent Award for Visiting Scholars

The Sargent Award provides support for visiting scholars to conduct botanical research that utilizes the living, library, and/or herbarium collections.

- ♦ 2012 **Hugh McAllister, Honorary Lecturer, University of Liverpool**

Taxonomic and phylogeographic studies of *Sorbus* and *Betula*

- ♦ 2012 **Claire Williams, Distinguished Scholar, Forest History Society**

Evolution dynamics of populations and conifer reproductive biology

- ♦ 2013 **Rosanne Healy, Post-doctoral Fellow, University of Minnesota**

Ectomycorrhizal fungi in forested vs well-spaced habitats

- ♦ 2014 **Andrew Groover, Research Scientist, US Forest Service**

The next generation of research for forest tree evolution and development

### Deland Award for Student Research

The Deland Award supports investigations by graduate and advanced undergraduate students working on the comparative biology of woody plants, including developmental biology, physiology, genetics, reproductive biology, or ecology.

- ♦ 2012 **Laura Lagonmarisino, PhD candidate, Harvard University**

Systematics, wood anatomy, and evolution of growth form in the neotropical Lobelioideae

- ♦ 2013 **Kathryn Weglarz, PhD candidate, Utah State University**

Influences on conifer biology of bacterial symbionts in Adelgid herbivores

- ♦ 2014 **Laura Garrison, PhD candidate, Brown University**

Phylogenetic distribution of naked buds in woody plants: Implications for phenology and global climate change

- ♦ 2014 **Kristel Schoonderwoerd, Master's student, Ludwig-Maximilians-Universität**

Female gametophyte and seed development in Theaceae

### Shiu-Ying Hu Student/Post-doctoral Exchange Award

The Shiu-Ying Hu Award supports scientific exchanges between Harvard University and the People's Republic of China.

- ♦ 2013 **Yong-Jiang Zhang, Post-doctoral Fellow, Harvard University**

Extent and magnitude of stem pressure in *Acer* and its relationship with xylem structure

# Collections



*Comprising living plants, herbarium specimens, and library and archival holdings, the collections of the Arnold Arboretum are among the largest and best documented in the world, and represent one of the most significant resources for the study of Asian flora held outside of Asia.*

As one of the museums that makes Harvard University a leader in the sciences, the Arnold Arboretum stewards collections that contribute to a greater understanding and appreciation of the natural world. In addition to a renowned living collection of temperate woody plants, the Arboretum curates important collections of pressed plant specimens and extensive library and archival resources. By enlisting new technologies, staff endeavor to expand how these collections are shared with scientists and the public around the world.

## “RAISED IN THE OPEN AIR”

### Securing The Future Of America’s First Public Tree Museum

With the opening of laboratories and growth facilities at Weld Hill, the Arnold Arboretum is positioned to shepherd a dramatic expansion in collections-based research. In the past, most investigations by staff and others utilizing Arboretum collections were conducted elsewhere, including in contracted laboratories in Cambridge. Now with a state-of-the-art research center within sight and reach of the living collections, the Arboretum has the means to conduct, assist, and promote new scholarship in exciting and innovative ways. Ensuring the long-term survival and strategic development of the living collections represents a crucial set of priorities in advancing the Arnold Arboretum’s mission as a world-class botanical institution.

At the most fundamental level, preserving the living collections requires the application of consistent and comprehensive horticultural care, a function carefully mapped out in the Arboretum’s Landscape Management Plan. Preservation also entails curatorial oversight through regular monitoring activities, enhanced in recent years through a field-check system designed

to inspect all accessioned plants on a 5-year cycle. Field checks record physical measurements, evaluate plant health, coarsely verify taxonomic identity, assess collections value, and confirm cartographic position. Curation staff incorporate

these data into the institution’s robust plant records, which for more than a century have fortified the collections’ scientific merit.

Change within the Arboretum’s dynamic landscape is driven by the acquisition of new and novel plants. Between 2012 and 2014, 1,065 new accessions were added to living collections. These accessions include seeds collected from wild populations, donations from other gardens, nursery purchases, clonal propagations of valuable Arboretum lineages, as well as the formal accessioning of existing “witness” trees that occur throughout the landscape. Over the past three years, the Arboretum has led or participated in

three major expeditions, beginning with a 2012 trip to eastern Virginia with the Morris Arboretum of the University of Pennsylvania with a specific focus on hardy populations of live oak (*Quercus*



Fruits of *Diospyros virginiana*, the common persimmon, one of 24 high-priority native species collected by the Arboretum on the 2013 trip collecting trip to Indiana and southern Illinois.

*virginiana*). In time, these seedlings will be trialed in warmer microclimates within the landscape as a way of coaxing this less-hardy species into cultivation in our region.

A 2013 trip to Indiana and southern Illinois yielded seed collections from 24 different high-priority species native to the region, including persimmon (*Diospyros virginiana*), silverbell (*Styrax americana*), and pawpaw (*Asimina triloba*). In 2014, the Arboretum teamed up with the Polly Hill Arboretum on Martha's Vineyard and the Morris Arboretum to explore the botanical riches of the Natural State, Arkansas. Among the 36 separate collections were three separate collections of the vernal witchhazel (*Hamamelis vernalis*), two viburnum species (*V. rufidulum* and *V. prunifolium*), as well as the rare maple-leaved oak (*Q. acerifolia*).

The value of the Arboretum's living collections and their associated documentation only begins with thoughtful stewardship, as these resources can only support discovery if they are readily available for use. The development of online tools that enable access to collections material, inventories, and data has been a monumental step in the Arboretum's aspirations to increase its reach and improve interactions with scholars. A recent database effort focused upon digitally acquiring and cataloging three vital sets of living collections paper archives was supported through a grant from the Institute of Museum and Library Services–Museums for America program (IMLS-MFA). This project reviewed and integrated data from over 55,000 historic accession cards, 53 archival accession books, and 1,800 hand-drawn and historic maps from the grounds into our database repositories. As a result of this endeavor, the Arboretum's plant records database now possesses accession and plant records for every plant grown on the grounds since the institution's founding in 1872. These data can be searched in a 'legacy search' on the Arboretum's webpage, and the historic maps can be viewed as legacy layers in the Arboretum's internal GIS.

Over the past two years, researchers have studied a wide range of plants in the collections, from maples to spireas to gingkos. Research use



Rachel Brinkman, Arboretum Horticulturist, and Gregory LaPlume, Arboretum Horticultural Technologist, drum lace the root ball of *Pinus strobus* 112-2010\*A (Eastern white pine) in the west nursery of the Dana Greenhouses as a part of fall planting for the conifer collection.

of these plants ranges widely, from the collection of silica-dried tissue for molecular analysis, tree microbiome research, the capture of real-time photosynthetic data, biomechanical studies, to micropropagation of conservation-status taxa. Studies include the analysis of arboretum soils, observations of spontaneous plants, and even assessing invertebrate populations. The scope and diversity of these projects suggest that as technology inaugurates new modes of inquiry, these exceptionally stewarded and documented collections from around the world will remain vital to the study of biodiversity.

# Scholarship in the Collections

## Arboretum Collections Support Wide Ranging Studies

Over the past three years, scholars working in fields of study ranging from botany to horticulture, entomology to mycology, and ecology to archaeology, accessed the living collection for a variety of short and long term projects. Staff assist scholars by coordinating the use of the living collections, collecting and shipping samples, scanning herbarium specimens, and exporting relevant data housed in curated databases in support of their project goals. Access to the living collections and the associated curated data has allowed scholars to conduct research projects in areas of genome sequencing<sup>1</sup>, taxonomic research<sup>2</sup>, molecular phylogeography and breeding<sup>3</sup>, origin and evolution<sup>4</sup>, climate change<sup>5</sup>, pollination ecology<sup>6</sup>, subsurface mapping<sup>7</sup>, and data analysis<sup>8</sup>.

The Arboretum strongly encourages and supports the use and distribution of its living collections for research, providing access to the plants growing in the collection, supplying voucher herbarium specimens, furnishing fresh or preserved tissue, or collecting propagules. Since 2012, the Arnold Arboretum has hosted scholars from twelve countries and dozens of institutions across the United States. Some 110 principle investigators accessed the living collections to advance work on more than 120 new research projects. These projects generated 2,134 points of access (the removal of material from accessioned plants in the living collection for/by a specific scholar or institution) for research purposes, 155 points of access for teaching, and 224 for general distributions to sister institutions.



The proximity of advanced laboratories for research at Weld Hill attract scientists and students from diverse fields to the living collection.

<sup>1</sup> Quentin Cronk (2012): Genome sequencing and other investigations of *Populus* and relatives.

<sup>2</sup> Robert P. Adams (2013): Taxonomic study of *Hesperocyparis revealiana* (Cupressus) from Baja, Mexico compared with *H. arizonica* and *Hes. montana* using leaf terpenoids.

<sup>3</sup> Hiroyuki Iketani (2014): Studies on molecular phylogeography, population genetics, and breeding system of *Malus* and related genera (tribe Pyreae of the Rosaceae) in Japan and East Asia.

<sup>4</sup> Sang-Hun Oh (2012): Origin and evolution of *Fagus multinervis* (Fagaceae) on Ulleung Island.

<sup>5</sup> Ailene Ettinger (2014): Exploiting the novel climates of arboreta to understand tree responses to climate change.

<sup>6</sup> Callin Switzer (2013): Buzz pollination among native pollinators.

<sup>7</sup> Christopher H. Roosevelt (2013): The Lay of the Land: Surface and Subsurface Mapping in Archaeology.

<sup>8</sup> Matthew Lobdell (2012): A Review of *Styrax* in Cultivation.

# A Bright Horizon for Horticulture

*New Leadership Advances Arboretum's Renewed Commitment to Collections*



Central to achieving the Arnold Arboretum's mission both as a research institution and as a public garden is the care, preservation, and expansion of its accessioned holdings of woody plants. In fact, the living collections and their associated documentation in the form of curatorial records, herbarium specimens, and library resources form the foundation for all activities engaging staff and the public, from explorations of nature by urban schoolchildren to advanced studies unravelling the effects of climate change in the laboratories at Weld Hill. Over the past three years, key personnel changes and new hires have established a highly skilled and cohesive leadership for horticulture, as part of the Arboretum's long-term commitment to pursuing the highest level of excellence in the care of its historical landscape and living collections.

In fall 2012, Stephen Schneider was named Director of Operations, a new position designed

to oversee horticulture, greenhouse, and nursery operations as well as facilities. While still a biology student at Northeastern University, Steve began his association with the Arboretum as a summer horticultural intern. Soon afterward he joined the



Stephen Schneider, Director of Operations

permanent staff as a Horticultural Technologist in 2003, and was named Manager of Horticulture in 2008. As Director of Operations, Steve has worked closely with the Curator of Living Collections to develop landscape management plans and strategies to ensure the long-term health of our plant collections and stewarded relationships with local, state, and federal government agencies, local community organizations, and other University departments. As part of his duties, he also led the search for two additional leadership hires within the department, which resulted in the selection of Andrew Gapinski as Supervisor (later Manager) of Horticulture and Tiffany Enzenbacher as Supervisor (later Manager) of Plant Production.



Andrew Gapinski, Manager of Horticulture

Andrew Gapinski was appointed as Supervisor of Horticulture in 2013, and his demonstration of exceptional leadership in staff and collections management was recognized a year later through his promotion to Manager of Horticulture. Andrew received his bachelors degree in horticulture from the University of Wisconsin-Madison and a masters degree in public horticulture from the University of Delaware, and gained collections experience as a horticulturist at the Morton Arboretum and as director of horticulture/curator at The Arboretum at Penn State. As Manager of Horticulture, Andrew leads a talented team of horticulturists and arborists in stewarding the Arboretum's Olmsted-designed

landscape and living plant collections. Andrew also leads enriching educational opportunities for emerging horticulture professionals as coordinator of the Isabella Welles Hunnewell Internship Program and the Arboretum's annual partnership with Norfolk County Agricultural High School.

To provide leadership for the Arboretum plant propagation and production activities, Tiffany Enzenbacher was appointed Supervisor of



Tiffany Enzenbacher, Manager of Plant Production

Plant Production in 2014 (promoted to Manager of Plant Production in 2015). Tiffany earned a Bachelor of Science degree from the University of Missouri, Columbia in plant sciences specializing in greenhouse management, as well as a Master of Science degree in Plant Pathology from Michigan State University. Her greenhouse and nursery experiences include four years as senior grower at the Morton Arboretum, as well as internships at the Chicago Botanic Gardens and Leider Greenhouses. She also gained extensive research experience through positions with the Department of Plant and Soil Sciences at Michigan State, the Pennsylvania State Universities, Gardengenetics LLC in Pennsylvania, and most recently at Boston College in the Department of Biology.

# Coming Into Leaf

## Using Collections to Track Plant Response to Climate Change

Like other museums, the Arnold Arboretum not only preserves consequential objects—in this case, a world-class collection of trees, shrubs, and vines—but also extensive collections of associated library and archival materials, photographs, and curatorial data. These resources can be crucial when a particular plant is selected for scientific investigation, as its identity, source, and other curated details may have bearing on study results. As part of its inventorying procedures for the living collections, curatorial staff conduct regular field checks of Arboretum plants, recording vital information on such factors as size and condition, and note relevant observations such as flowering and fruiting times. Taken together, these data tell the unique stories of Arboretum plants for both science and posterity.

A good example of how this information can be used to generate new knowledge is the work of Boston University Biology Professor Richard Primack. A former Arboretum Putnam Fellow, Primack has in the past used herbarium specimens, archival photographs, and personal observations to study how warming temperatures have induced Arboretum plants to flower as much as ten days earlier than those recorded a century ago. For his latest project at the Arboretum initiated in 2012, Primack set out to investigate whether leaf emergence in woody plants can also serve as an indicator of climate change, and whether there may be evolutionary and ecological advantages for plants to leaf out at different times.

To carry out his research, Primack and a volunteer team combed the Arboretum collections from early March to the end of May to record the leafing out times for more than 1,000 species of native and exotic plants. He found that a ten week span separates those plants that leaf out the earliest—like honeysuckles and privets—and those that leaf out the latest, including some of the pines and evergreen rhododendrons. Early-leafing species experience a longer growing season that might make them more competitive in the wild, but this advantage comes at the price of exposing tender leaves to possible frost damage. Conversely, those species that leaf out later are less likely to incur frost damage, but may be less competitive due to their shorter growing season.

In addition to the Arboretum, the study is being replicated at seven other botanical institutions in the US, Canada, Germany, and China. In analyzing the collected

data, Primack and his colleagues hope to identify patterns that might increase our knowledge of variation in leafing behavior between shrubs and trees, deciduous and evergreen plants, and across species. They will also see if evidence collected in the Arboretum landscape is similar to other results gathered in other parts of the world. As evidence mounts that much of our biodiversity may diminish as climate change progresses, Arboretum plants and their associated data may contribute significantly to our understanding of which plants may be at the greatest risk of disappearing.



Boston University Professor Richard Primack (left) and Harvard University Professor Charles Davis (right) observe and record plant phenology in the Leventritt Shrub and Vine Garden.



# Maps and Legends

## New Applications Expand Access to Collections Documentation

How do you find the plant you're looking for at the Arboretum? Not long ago, locating a particular plant to observe, to collect material for the laboratory, or simply to visit to admire its seasonal beauty required significant help from staff to pour over plant lists and decipher hand-drawn maps. As part of ongoing efforts to increase public access to the collections and their rich documentation, the Arboretum has developed new technologies over the past two years that empower both remote and on-site visitors to pursue more robust and autonomous explorations of the Arnold Arboretum and its plants.

For decades, staff have used global positioning tools to capture the georeferenced locations of each accessioned plant in the collection as part of the Arboretum's extensive curatorial documentation. However, since available information was restricted to complex software systems, sharing and analyzing these data both internally among staff and externally with researchers was challenging and time consuming. To identify an integrated solution, Arboretum IT and curation staff collaborated with Harvard's Center for Geographic Analysis and developers of BG-BASE (our collections database system) to orchestrate a GIS (Geographic Information System) to electronically link plant locations with curatorial details.

In a comprehensive project guided by former Putnam Research Fellow Brian Morgan, the 2011 launch of Collection Researcher delivered the first online map application to link current and historical information about Arboretum plants with the means to pinpoint them in the landscape. This project represented a leap forward in sharing the Arboretum's searchable inventory of some 15,000 curated trees, shrubs, and vines globally by linking Arboretum data with a powerful GIS

(geographic information system) for desktop explorations of the Arboretum.

On Lilac Sunday 2012, the Arboretum launched two applications, Mobile Interactive Map and AA Navigator, both optimized for mobile devices to share the functionality of Collections Researcher more widely, including with visitors in our landscape. Users could now search for individual plants and learn what is known about them, like their taxonomy, growth habit, condition, size, and age. Links opened access to additional external databases for further study at the species level, including photographs with Google Images, scientific papers with Google Scholar, herbarium specimens deposited at the Harvard University Herbaria, and even DNA sequences for the plant held by GenBank.

Public testing and evaluation of these pilot applications led to the development and 2013 release of Arboretum Explorer, signalling the future of GIS-enabled access to the living collections and their data for staff, researchers, and the general public. Whether standing on Bussey Hill or on another continent, Arboretum Explorer offers multiple ways to explore the Arboretum in the palm of your hand, from taking self-guided tours and discovering seasonal highlights to sharing plants and their images on social media websites like Flickr and Facebook.

Arboretum Explorer represents a landmark accomplishment in our commitment to leverage technology to share our resources widely. This innovative and modern web application can be used to create your own tours, perform multi-faceted searches, and share and download plant information. With these and other ongoing initiatives, the Arboretum continues to pioneer new and exciting ways for people to interact with our plants, our landscape, and the plant kingdom in general.

# TREASURES ON VIEW

## Increasing the Reach of the Horticultural Library and Archives

The Arnold Arboretum Horticultural Library preserves over 100,000 volumes of literature in Jamaica Plain and Cambridge pertaining to woody plants over a range of disciplines, representing a critical supporting resource for the study of the living collections. In addition to these bibliographic collections, staff curate photographic collections and an extensive archive of institutional records, personal papers, and correspondence. Taken together, these carefully preserved and documented materials not only tell the story of the Arboretum and its plants, but also reveal a great deal about our participation in the history of plant exploration, botanical science, and horticulture worldwide.

Photographs have historically played an important role in the Arboretum's efforts to document plant diversity, habitats, and horticulture. Today, the Arboretum preserves approximately 68,000 photographs—including prints, slides, and digital images—that illustrate the history of plant study at the Arboretum. A number of grant-funded projects and cooperative initiatives over the past decade have enabled staff to digitally scan and document our historical image collections to share them more broadly. To date, approximately 10,000 of our photographs can be accessed and viewed through online exhibits on the Arboretum website or through the Visual Information Archive (VIA) of Harvard University, or through Digital Commonwealth. Our analytics indicate that our image galleries are some of the most visited sections of our website, with a large number of hits coming from Asia. To keep this content fresh and up to date, we have been systematically updating our materials to create a robust portal for accessing our digitized content.

The Arnold Arboretum Archives comprise some 475 linear feet of materials representing over 330 separate collections of personal papers, field notes,

travel records, journals and more—a vast expanse of information stretching back 140 years. During this period we have received a large quantity of archival material from staff members which we have incorporated in to several significant preexisting collections, including visitor services, children's education, and facilities. Exploring this treasure trove has become markedly easier through staff efforts to characterize the contents of individual collections through descriptive finding aids posted to the Arboretum Library website. Access to digital resources that inventory the Archives provides another valuable layer to the reference services that are a hallmark of the Library's mission.

Work to reveal more of the Library's rich holdings to online audiences has been complemented by increased opportunities to share these materials on site at the Arboretum. Since 2012, the staff have mounted 26 exhibitions of materials drawn from the Archives, displayed in the Reading Room of the Library or in conjunction with events and seminars at the Weld Hill Research Center. Following renovations made to the Hunnewell Building Visitor Center at the end of 2012, the Library and Archives gained exhibit space to present temporary exhibits for the public. Recent displays there have featured Native Peoples artifacts found on the grounds by E.J. Palmer and Alfred Fordham, historical postcards with colorful scenes of the grounds, and an examination of the crabapples of the Arboretum.

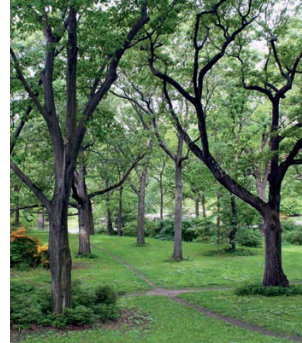
Through these and other activities directed at serving both science and the public at large, the Horticultural Library continues to play a vital role in advancing the Arboretum's work in research and education. Whether you browse in the Reading Room or explore holdings remotely on your computer, finding the information you need keeps getting easier.

# Arnold Arboretum Collections at a Glance

## Living Collections

As of December 2014, the living collections of the Arnold Arboretum comprised **14,836** plants belonging to **10,251** accessions representing **3,818** taxa (including 2,086 species). From January 1, 2012 to December 31, 2014:

- Additions to the permanent collections: **463**
- Existing witness trees accessioned: **343**
- Removals from the permanent collections: **885**
- Distributions to outside scholars and gardens: **2,513**
- Field checks & observations on accessioned plants: **19,608**



## Herbarium Collections

As of December 2014, the Herbarium of the Arnold Arboretum (A) housed in Cambridge at the Harvard University Herbaria held **1,477,535** mounted plant specimens. Also as of this date, the Arnold Arboretum Herbarium of Cultivated Plants in Jamaica Plain held **133,250** specimens, of which **47,066** represented vouchers from accessioned plants.

- Vouchers added to the Arnold Arboretum (A) Herbarium in Cambridge: **43,547**; in Jamaica Plain: **387**
- Percentage of vouchers in the Herbarium of Cultivated Plants audited in 2014: 28%



## Library and Archival Collections

As of December 2014, the Horticultural Library of the Arnold Arboretum comprised **22,976** books; **10,900** periodical volumes; **47,000** film/video/photographic items; **21,000** digital images; and **475** linear feet of archival materials representing **335** separate collections.

- Volumes added to the collection: **638**
- Periodicals added to the collection: **705**
- Online additions: Library Leaves blog, Weekly Featured Images, Gallery of Ernest Wilson's New England Trees
- Hours contributed by library interns: **1050**
- Exhibitions mounted since 2012: **26**



# Conservation



*Our historical commitment to conserving natural resources and biodiversity is demonstrated through a wide variety of collaborative and institutional initiatives that further plant conservation efforts worldwide.*

Since its founding, the Arnold Arboretum has worked to advance our knowledge of the plant kingdom by collecting, distributing, and studying species from around the world. Carefully preserved and cared for in our landscape, accessioned plants can be important individuals for *ex situ* conservation efforts. As more and more species become threatened in the wild through habitat destruction and the effects of climate change, the value of well-documented collections held by the Arboretum gain critical importance in their capacity to sustain living germplasm for scientists, colleague institutions, and even reintroduction efforts.

# A Phoenix for Ashes?

## Collaborations Seek to Preserve Genetic Diversity of a Threatened Native

Plants growing across the Arboretum's 281-acre landscape can delight, confound, and inspire in limitless ways. Each of more than 15,000 documented trees, shrubs, and woody vines in the living collections holds immense value as a specimen for study, particularly when collected from a native population and rigorously documented for the entirety of its existence. In the past few decades, as more of our biodiversity disappears through pressures on habitats and the effects of climate change, institutions that curate plants have become critical as gene banks with the potential to safeguard biodiversity from permanent loss.

While conserving plants where they occur naturally remains our best defense against extinctions, cultivating individuals from distinct populations outside of their habitats—*ex situ* conservation—may be the only alternative for some critically endangered taxa. Many others bear seeds that can be dried and stored for long periods at low temperatures, providing a more space-efficient and cost-effective means of preserving the full complexity of a plant's genetic character.

Over the past two years, the Arnold Arboretum has exercised both approaches to *ex situ* conservation to assist national efforts to preserve native ashes (*Fraxinus* spp.) under attack by the emerald ash borer (EAB). Since its accidental introduction in the Midwest in the 90s, the beetle has gradually moved in all directions, laying waste to wild and cultivated ash and threatening the entire genus on this continent with extinction. With no resistance yet identified among the American ash, tens of millions of trees have already been lost, and perhaps billions more are at risk.

In support of the federal government's collaborative effort to protect the genetic diversity of remaining populations, the Arboretum participated in several trips to collect seeds from ash populations in northern Pennsylvania and southern New York.



*Fraxinus* (ash) collection on Bussey Hill.

The relatively recent arrival of EAB to this region means that time is running out to inventory and collect regional ash diversity before the pest exerts its full destructive force on these forests. Gathering from different sites and habitat types to maximize the genetic pool, the collecting team—including Curator of Living Collections Michael Dosmann—amassed seed from nearly 200 trees from 21 wild populations of white ash (*F. americana*), green ash (*F. pennsylvanica*), and black ash (*F. nigra*).

Some of the seed gathered in these expeditions will likely grow into plants that find their way into the Arboretum landscape, adding examples of their genetic character to existing holdings of *Fraxinus*. More importantly, seed has been integrated into the USDA's National Plant Germplasm System for preservation and to supply the research needs of scientists studying the natural history, biology, and plant-insect interactions of ash trees—all of which require further study. Should EAB one day diminish as a threat, banked seed may even help resurrect ash populations where they have disappeared.

# Education



*As a department of Harvard University, the Arnold Arboretum shares its collections and landscape with educators and students from a wide array of disciplines and spanning all generations for a lifetime of learning.*

Deeply and historically committed to enhancing our understanding of the plant kingdom, the Arnold Arboretum conducts educational programs for multiple audiences. Graduate and undergraduate students use the Arboretum landscape and collections for curricula ranging from introductory botany to urban ecology. The Arboretum's education programs for children and adults represent a community resource for the study of plants and their environments, leveraging the institution's rich collections and expert staff.

# Nature Learning for Preschool Scientists

## The Arboretum Enhances a Partnership with Head Start

The wonders of the natural world fascinate at every age, and the Arnold Arboretum is committed to fostering educational experiences that support lifetime learning. Formal investigations of woody plants and their environments begin with programs for urban preschoolers, primarily through a longtime partnership with South Side Head Start in neighboring Roslindale, Massachusetts. This fall, Arboretum school science specialist Ana Maria Caballero began biweekly visits to South Side classrooms with plant materials and activities that engage the children with science. Funded by the Nature Study Fund for Urban Children, the enhanced collaboration represents another step forward in the Arboretum's efforts to inspire the natural curiosity of Boston's urban schoolchildren.

The Arnold Arboretum first engaged teachers and children at Head Start as part of the Field Study Program in 2007. In this age-appropriate program, volunteer guides lead multi-sensory explorations of the Arboretum landscape in spring, summer, and fall. Visits are designed to help children gain comfort in natural surroundings, cultivate object-based learning by collecting plant materials, and attempt their first observational drawing. The experiences leverage the children's excitement and keen interest in exploring new things, making fresh discoveries, and sharing what they've learned with peers and adults. Their enthusiasm, often considerably amplified in a natural outdoor setting like the Arnold Arboretum, proves contagious, providing truly memorable interactions for teachers and volunteers as well.

Beginning in fall 2012, the Arboretum devoted additional resources to deepen its commitment

to preschool learning and improve educational outcomes at South Side Head Start. Through planning with staff and teachers, Arboretum educators designed a new curriculum that replicates the successful model of classroom instruction and mentoring that the Arboretum initiated at Agassiz Elementary School and the Boston Teachers Union School. The Arboretum's science education specialist, Ana Maria Caballero, visited South Side classrooms twice weekly to augment life science investigations, sharing plant material like magnolia and cherry flowers, conifer branches, and sweet potato vines. Through observations of plants, drawings, simple experiments, and art projects, children enjoyed their first forays into scientific investigation that will provide a foundation for future field studies as they advance through the primary grades.

While the collaboration focuses on building young investigative skills, it also helps instructors at the center to increase their comfort level in object-based teaching. They report marked growth in the children's enthusiasm for science and their abilities to use new words and make careful observations. The Arboretum has also shared an array of books with the center, further broadening the conversation on natural themes. This spring, children in Head Start will visit the Arboretum landscape with fresh skills in observing, communicating, and representing the natural world. With repeated experiences in the classroom and in the field, the Arboretum helps foster the innate capacity of our youngest scientists to explore and be inspired by the world opening around them.

# Celebrating Biodiversity, One Plant At a Time

## Tree Mobs Offer Expert Introductions to Plants, Collections, and Research

A guided tour of the Arboretum landscape offers visitors a big picture view of the living collections as a diverse and scientifically significant assemblage of Earth's temperate woody flora. With more than 15,000 documented plants and many hundreds more growing spontaneously in the Arboretum's three natural woodlands, paying close attention to any particular organism can take a back seat to the breathtaking sweep of Olmsted's naturalistic vision. With the introduction of Tree Mobs™ in spring 2012, Director William (Ned) Friedman endeavored to upend that impression, creating intimate opportunities to spotlight, study, and celebrate individual plants.

Tree Mobs, developed and managed by Pam Thompson, Manager of Adult Education, are brief interactions that occur in the Arboretum landscape, designed to encourage visitors to cultivate a more intimate appreciation of the living collection, one tree, shrub, or vine at a time. Lifting a page from the 'flash mob' phenomenon that inspired them, Tree Mobs favor spontaneity and participation, and may attract a small group or a large gathering. Visitors are directed by email notification, social media posting, or signs in the landscape to a featured plant. The Tree Mob begins with an expert or scientist addressing those gathered about the plant or its family, its use or importance to research, or a specific and often seasonal aspect of its biology. Presentations are scheduled for a half hour but are often extended as the short burst of plant knowledge is followed by questions and discussion from the "mob."



An autumn Tree Mob focuses on the *Juglans* (walnut) collection.

This novel approach to learning benefits from the ephemeral nature of botanical phenomena, as Tree Mobs may be organized in short time to take advantage of intriguing yet fleeting occurrences tied to morphology like flowering, leafing out, and senescence (leaves aging). Between its inception and October 2014, 86 Tree Mobs have engaged nearly 2,000 participants and have provided a fun and engaging educational forum for interactions between Arboretum staff and the public. At its heart, each Tree Mob breaks down the barriers that can exist between lay people and science. By moving away from the formality that characterizes classroom encounters or tours, Tree Mobs remind us that outdoor learning can be fun and inspiring at any age and in every season.



## Educational Outreach and Visitor Engagement



### Children's Education Programs

During the 2012, 2013, and 2014 school years, the Arnold Arboretum conducted field study programs for Boston area students in pre-school through the fifth grade. During this period, Arboretum educators also participated in teaching science to students at a neighborhood elementary school.

**2012**—55 field study programs conducted; 93 classrooms and 1,962 students participated;  
**2013**—62 field study programs conducted; 103 classrooms and 2,102 students participated;  
**2014**—64 field study programs conducted; 112 classrooms and 2,161 students participated.

### Adult Education Programs

The Arboretum offers a variety of learning opportunities for adults centered on its collections of temperate woody plants and the expertise of staff. Courses, workshops, and lectures provide continuing education in botany, horticulture, the landscape and garden arts, and related disciplines.

#### 2012–2014

- Classes/Lectures scheduled: **171**
- Classes/Lectures conducted: **157**
- Registrants to programs: **5,704**
- Partnering organizations for programs: **9**
- Tree Mobs Held: **86**

### Visitor Engagement Programs

Free and open to the public every day of the year, the Arnold Arboretum connects with the visiting public through interactions with docent tour guides, volunteer interpreters stationed in the landscape, the Visitor Center in the Hunnewell Building, as well as through a variety of special programming and opportunities for families.

#### 2012–2014

- Estimated annual visitors: **250,000**
- Visitor Center: **126,947**
- Guided Tours: **482**
- Tour Attendance: **5,929**
- Interpreter Interactions: **2,020**
- Volunteer Hours: **8,799**

# Statement of Activities

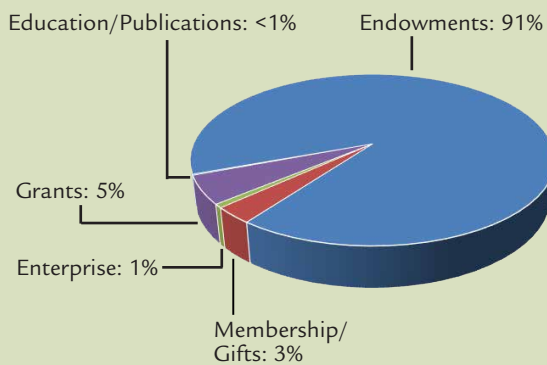
Beyond funding secured for sponsored research, the Arboretum largely relies on the past and present philanthropy of its friends and members who, for 140 years, have given generously to the institution. The tables and figures here reflect the financial health of the Arnold Arboretum of Harvard University.

Fiscal Year 2012: July 1, 2011—June 30, 2012

## INCOME

Endowments	11,521,842
Membership/Gifts	391,440
Enterprise	87,567
Grants	674,817
Education/Publications	25,207

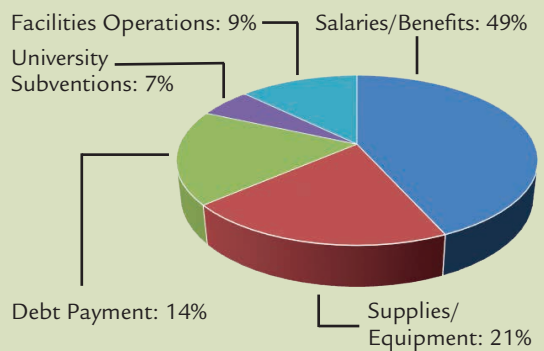
**Total Income:** 12,700,874



## EXPENSES

Salaries/Benefits	5,979,575
Supplies/Equipment	2,827,053
Facilities Operations	2,485,288
University Subventions	772,421
Debt Payment	1,762,011

**Total Expenses:** 13,826,348  
**Net Deficit:** (1,125,474)



# Statement of Activities

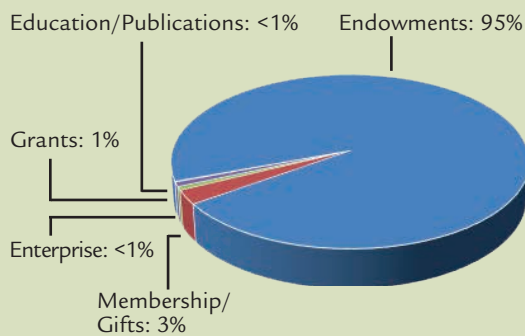


Fiscal Year 2013: July 1, 2012—June 30, 2013

## INCOME

Endowments	12,057,593
Membership/Gifts	329,671
Enterprise	83,999
Grants	101,082
Education/Publications	19,605

**Total Income: 12,591,952**

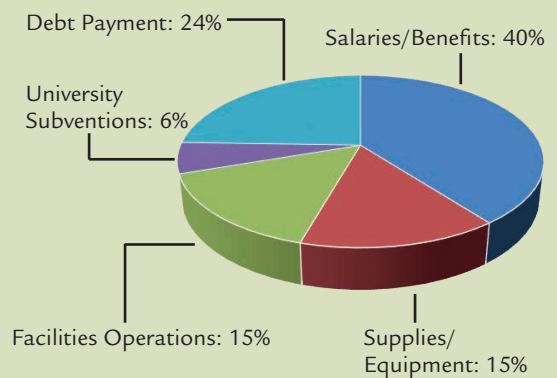


## EXPENSES

Salaries/Benefits	5,445,097
Supplies/Equipment	2,036,856
Facilities Operations	2,105,980
University Subventions	793,734
Debt Payment	3,365,500

**Total Expenses: 13,747,168**

**Net Deficit: (1,155,217)**



# Statement of Activities

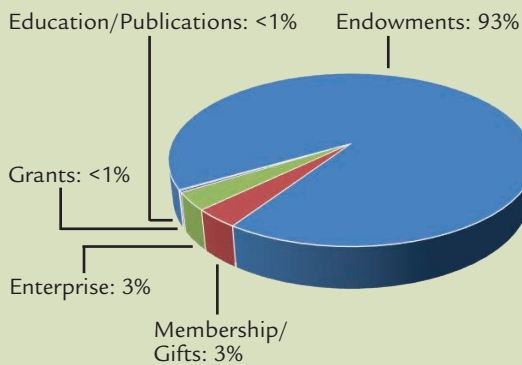


Fiscal Year 2014: July 1, 2013—June 30, 2014

## INCOME

Endowments	12,250,500
Membership/Gifts	457,559
Enterprise	437,390
Grants	43,720
Education/Publications	23,796

**Total Income: 13,212,965**

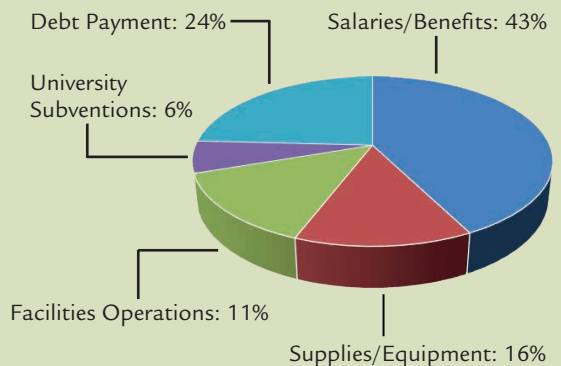


## EXPENSES

Salaries/Benefits	5,825,069
Supplies/Equipment	1,841,794
Facilities Operations	1,907,335
University Subventions	830,086
Debt Payment	3,318,981

**Total Expenses: 13,723,265**

**Net Deficit: (510,300)**



# Arnold Arboretum Staff

January 1, 2012 through December 31, 2014



## Administration and Operations

- John Barbosa, *Custodial Crew Chief*
- Donna M. Barrett, *Accounting Associate*
- Cynthia Cushman, *Human Resources Coordinator*
- Amie Evans, *Executive Assistant* (until 9/18/14)
- William (Ned) Friedman, *Director*
- Edin Guerra, *Custodian*
- Donna Heimlich, *Senior Human Resources Consultant*
- Amina Hussain, *Senior Human Resources Consultant* (until 12/6/13)
- Matthew Jordan, *Director of Finance* (from 12/17/12)
- Andrea Nix, *Director of Finance* (until 9/23/12)
- Karen Pinto, *Staff Assistant*
- David J. Russo, *Facilities Manager*
- Stephen Schneider, *Director of Operations*
- Tracy Smith, *Assistant Facilities Manager*

## Curation

- Joyce Chery, *Curatorial Fellow* (2013)
- Michael Dosmann, *Curator of Living Collections*
- Susan Hardy Brown, *Curatorial Assistant*
- Kyle Port, *Manager of Plant Records*
- Kathryn Richardson, *Curatorial Assistant*
- Stephanie Stuber, *Curatorial Fellow* (2012)
- Jordan Wood, *Curatorial Fellow* (2014)

## Education and Public Programs

- Ana Maria Caballero, *Children's Education Consultant* (2012)
- James Leighton, *Visitor Education Assistant* (until 12/2/14)
- Brett McNeilly, *Visitor Education Assistant* (from 4/25/13 until 8/5/14)

- Daphne Minner, *Manager of Public Programs* (from 8/1/13 until 11/4/14)
- Maggie Redfern, *Visitor Education Assistant* (until 10/14/14)
- Nancy Sableski, *Manager of Children's Education*
- Pamela Thompson, *Manager of Adult Education*
- Sara Van Note, *Children's Education Science Specialist* (from 8/26/13 to 7/31/14)
- Julie Warsowe, *Manager of Visitor Education* (until 9/4/13)
- Sheryl L. White, *Visitor Education Assistant*

## External Relations and Communications

- Jon Hetman, *Director of External Relations & Communications*
- Wendy Krauss, *Membership Coordinator*
- Jennifer Leigh, *Development Database Specialist* (until 5/17/13)
- Barbara Murphy, *Development Assistant*
- Nancy Rose, *Editor of Arnoldia*
- Sarah Wentz, *Director of Development* (from 2/4/12 until 1/30/14)

## Greenhouse

- John Herbert Alexander III, *Plant Propagator*
- Tiffany Enzenbacher, *Supervisor of Plant Propagation* (from 7/20/14)
- Bob Famiglietti, *Greenhouse Horticultural Technologist*
- Irina Kadis, *Greenhouse Curatorial Assistant* (transferred to Curation 11/1/13)

## Horticulture

- Kevin Block, *Horticultural Technologist* (until 6/15/13)

## Activities and Staff

- Rachel Brinkman, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- Matthew Connelly, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- John S. DelRosso, *Head Arborist*
- Robert Dowell, *Apprentice*
- Robert Ervin, *Arborist*
- Kirsten Ganshaw, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- Andrew Gapinski, *Supervisor of Horticulture* (from 5/3/13 to 7/18/14); *Manager of Horticulture* (from 7/19/14)
- Scott Grimshaw, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- Dennis Harris, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- Wesley Kalloch, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- Jennifer Kettell, *Horticultural Technologist* (until 11/14/14)
- Brendan McCarthy, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- James Papargiris, *Working Foreman*
- Susanne Pfeiffer, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)
- Nima Samimi, *Gardener* (until 11/14/14); *Gardener II* (from 11/15/14)
- Kyle Stephens, *Arborist*
- Mark Walkama, *Horticultural Technologist* (until 11/14/14); *Arboretum Horticulturist* (from 11/15/14)

### Information Technology

- Stephen Hill, *IT Systems Administrator*
- Victoria Wei Lin, *Database Specialist* (from 1/21/14)
- George Morris, *Director of Information Technology*
- Donna Tremonte, *Applications Programmer*

### Library

- Elizabeth Francis, *Library Assistant* (until 11/17/13)
- Larissa Glasser, *Library Assistant*
- Lisa E. Pearson, *Head of Library & Archives*
- Stephanie Turnbull, *Library Assistant* (from 3/31/14)

### Research

- Julien Bachelier, *Post-doctoral Fellow* (until 3/30/13)
- Stuart Davies, *Senior Research Scientist* (until 2/26/12)
- Peter James Del Tredici, *Senior Research Scientist* (until 11/30/13)
- David Des Marias, *Research Associate*
- Ailene Ettinger, *Putnam Fellow*
- Daniel Flynn, *Research Associate*
- Elizabeth Forrester, *Postdoctoral Fellow*

- William (Ned) Friedman, *Arnold Professor of Organismic and Evolutionary Biology*
- Jessica Gard, *Faculty Assistant*
- Guangyou Hao, *Putnam Fellow* (until 5/31/14)
- Robin Hopkins, *Assistant Professor of Organismic and Evolutionary Biology*
- Brian Leib, *Weld Hill Greenhouse Manager*
- Juan Losada, *Post-doctoral Fellow*
- Sarah Mathews, *Senior Research Scientist* (until 8/30/13)
- Francesco Molina, *Graduate Student*
- Ekaterina Morozova, *Lab Technician* (until 8/15/14)
- Cary Pirone, *Putnam Fellow* (until 3/15/13)
- Rebecca Povilus, *Graduate Student*
- Frederico Roda, *Postdoctoral Fellow*
- Faye Rosin, *Director of Research Facilitation*
- Shayla Salzman, *Graduate Student*
- Jehane Samaha, *Lab Technician*
- Jessica Savage, *Putnam Fellow*
- Tim Savas, *Lab Technician*
- Francesca Secchi, *Post-doctoral Fellow* (until 8/30/12)
- Sevan Suni, *Postdoctoral Fellow*
- Campbell Webb, *Senior Research Scientist*
- Elizabeth Wolkovich, *Assistant Professor of Organismic and Evolutionary Biology*
- Stacey Young, *Putnam Fellow* (until 9/30/14)
- Grace Yu, *Lab Technician*
- Maciej Zwieniecki, *Senior Research Scientist* (until 8/30/12)

### Associates

- Phyllis Andersen
- Robert Cook
- Peter Del Tredici
- Brian Donahue
- Daniel Flynn
- Andrew Groover
- Ling Guo
- Abby Hird
- Jose Hormaza
- Jianhua Li
- Mike O'Neal
- Richard Pagett
- Jayesh Paghda
- Cary Pirone
- Kristel Schoonderwoerd
- Jason Sardano
- Emily Scherbatskoy
- Emily Silver
- Stephen Sponberg, *Curator Emeritus*
- Stacey Young

## Volunteers (2012–14)

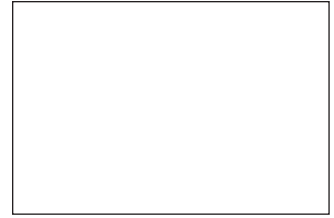
- ✦ Ingrid Ahrhanson
- ✦ Susan Adams
- ✦ Marty Amdur
- ✦ Susan Anemone
- ✦ Roberta Apfel
- ✦ Sarah Atherton
- ✦ Barbara Balasa
- ✦ Cheryl Balukonis
- ✦ Debbie Banton
- ✦ Marygrace Barber
- ✦ Karen Barnett
- ✦ Kathy Bergman
- ✦ Zach Bolles
- ✦ Shaheen Bossi‡
- ✦ Vanessa Bouliki
- ✦ Penny Caponigro
- ✦ Mary Chase
- ✦ Pam Chatis
- ✦ Lydia Chen
- ✦ Patricia Cohen
- ✦ Amy Cohen-Rose
- ✦ Corinne Comross-Abercrombie
- ✦ Kathleen Corcoran
- ✦ Sarah-Grace Dady
- ✦ Janice Danielson
- ✦ Molly de Blanc
- ✦ Susan DeLuca
- ✦ Robert Devens
- ✦ Eleanor Devens
- ✦ Catherine Donaher
- ✦ Frances Doyle
- ✦ Sara Driscoll
- ✦ Lynn Evans
- ✦ Walter Evans
- ✦ Elsbeth Falk
- ✦ Sidney Fiarman
- ✦ Rena Foley
- ✦ Judith Freedberg
- ✦ Cecille Friedler
- ✦ Gerald Friedler
- ✦ Steven Friedman
- ✦ Nancy Gilson
- ✦ Ann Glick
- ✦ Marty Griffin
- ✦ Susan Hampton
- ✦ Carol Harris
- ✦ Leah Hartman
- ✦ Jennifer Hauf
- ✦ Anne Heller
- ✦ Audrey Henderson
- ✦ Frank Hurley
- ✦ Jim Huse
- ✦ Anette Jacobs
- ✦ Marc Jaffee
- ✦ Theresa Kane
- ✦ Robert Kane
- ✦ Bart Kelso
- ✦ Nicholas Kerpan
- ✦ Joel Kershner
- ✦ Maryanne King
- ✦ Roberta Koffman
- ✦ Nancy Kruger
- ✦ Rhoda Kubrick
- ✦ Elsa Lawrence
- ✦ James Leighton
- ✦ Linda Lesyna
- ✦ Naomi Lev
- ✦ Claire Levy
- ✦ Faye Lieb
- ✦ Rose Marques
- ✦ Robert Mayer
- ✦ Colin McArdle
- ✦ Chris McArdle
- ✦ Cheryl McCarthy
- ✦ Mike McCarthy
- ✦ Ana Maria Maguire
- ✦ Mary Mooradian
- ✦ Mary-Anne Morrison
- ✦ Aline Newton
- ✦ Zack Parisa
- ✦ Jane Patrick
- ✦ Angela Philactos
- ✦ Jane Phipps
- ✦ Elizabeth Pierce
- ✦ Michael Power
- ✦ Jaime Pullen
- ✦ Sue Rasalla
- ✦ Margaret Reilly‡
- ✦ Peter Reinhart
- ✦ Susan Richey
- ✦ Rob Riman
- ✦ Linda Roistacher
- ✦ Carol Rose
- ✦ Susan Sargent
- ✦ Kevin Schofield
- ✦ Angela Sciaraffa
- ✦ Ajay Sequeria
- ✦ Anne Serrell-Jones
- ✦ Martha Shaw
- ✦ Chuck Sherzi
- ✦ Elise Sigal
- ✦ Patricia Simmons
- ✦ Maria Simoneau
- ✦ Curt Smith
- ✦ Ruthann Sneider
- ✦ Mia Snow
- ✦ Meira Soloff
- ✦ Judy Steul
- ✦ Mike Stone
- ✦ Brendan Stuart
- ✦ Nancy Stutzman
- ✦ Patricia Suhrcke
- ✦ David Tarbet
- ✦ Linda Taylor-Brown
- ✦ Priscilla Thomas
- ✦ Jason Tucker
- ✦ Tom Vance
- ✦ Emily Wachtel
- ✦ Amanda Wagner
- ✦ Joanna Watson
- ✦ Dorothy Wawrose
- ✦ Ellen Weinberg
- ✦ Florrie Wescoat
- ✦ Emily Wheeler
- ✦ Cindy Whitcome
- ✦ Burt White
- ✦ Kate Wood
- ✦ Elizabeth Wylie

‡ *deceased before 1/1/2016*



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