Plants are fundamental to life, from the air that we breathe to the food that we eat. Science is the foundation of botanic gardens, from understanding how to grow plants in the gardens to conserving biodiversity outside the gardens. Thus, plant science serves as a key programmatic element of Denver Botanic Gardens.
As a regional research center, we play a critical role in the conversation, preservation and documentation of Colorado’s biodiversity. Plant, fungal and insect collections document species occurrence, deepen our knowledge of biodiversity, provide primary data for scientific studies and inform conservation.  Field measurements and tissue samples build the body of data that informs protection decisions for plant species. Seed collections aid in long-term preservation.

**Conservation Programs**

**Seed Conservation**

Regional seed collecting, preservation and germination experiments support ex situ conservation of rare species and restoration efforts. In 2015, we collected 2,763 seeds of *Penstemon penlandii* (an endangered species) and 22 separate seed collections of *Sclerocactus brevipes* (threatened), *Sclerocactus wetlandicus* (threatened), and *Sclerocactus glaucus* (threatened). We grew threatened and endangered species at Denver Botanic Gardens for display and educational purposes. For two of these species, *Ipomopsis polyantha* (endangered) and *Penstemon penlandii*, we conducted germination experiments to develop appropriate protocols for future reintroductions, if needed. The *P. penlandii* study supported our conservation genetics work of this species.

**Population Biology**

As one of our longest running conservation programs, long-term demographic monitoring and niche modeling are used to assess threats to rare species and advise management strategies. 2015 marked our 21st year of long-term monitoring of *Astragalus microcymbus* (a candidate for listing), our 20th year for *Penstemon harringtonii* (a US Bureau of Land Management [BLM] and US Forest Service sensitive species) and our eighth year for *Sclerocactus glaucus*.

**Graduate Student Advising**

We expanded our graduate student training, including a more formal partnership with the Department of Integrative Biology at the University of Colorado Denver (UCD) where several Gardens staff are affiliate faculty. Graduate students play a role at the Gardens through Graduate Research Assistantships. Currently, Rebecca Hufft, PhD, is the primary advisor of Carla DeMasters, a masters student at UCD, and Jennifer Neale, PhD, co-advises a doctoral student at the University of Denver. Additionally, these staff along with Melissa Islam, PhD, and Sarada Krishnan, PhD, serve on graduate committees at local universities.

**Phenology**

Partnersing with the USA National Phenology Network (USANPN) and Project BudBurst, Gardens staff and volunteers make phenology observations of plants at our three locations: York Street, Chatfield Farms and Mount Goliath. All of these data are publicly available through our partners’ websites.

**In 2015 we Made**

**649 TOTAL PHENOLOGY VISITS**

Over 76 days to 96 individual plants.

**Conservation Programs (continued)**

**Conservation Genetics**

Our conservation genetics program investigates population level diversity and patterns in some of our state’s rarest species. Through collaboration with the BLM and the US Fish and Wildlife Service, we are addressing questions of species identity, genetic diversity and distribution, which incorporate both population genetics and phylogenetics, to inform management decisions. In 2015, we initiated a project examining genetic diversity across in situ populations and ex situ collections of *Penstemon penlandii*. Additional genetics work continued with *Sclerocactus populations in Colorado* and with the Dudley Bluffs mustards (*Physaria congesta*; *Physaria abbreviata*, both threatened).

**Native Habitat Restoration**

At Denver Botanic Gardens Chatfield Farms, we are restoring 5.5 acres of degraded riparian habitat. In 2015, we initiated the first phase of the Native Habitat Restoration Project which included a foraging survey. Currently, stream structures are being designed to improve hydrology. In 2016 plans will be developed for long-term monitoring of vegetation, invertebrates and water quality. This work is funded by the Borgen Family Foundation and the National Fish and Wildlife Foundation Five Star and Urban Waters Program.

**Seed Conservation**

Collected in 2015:

- 48,548 rare and imperiled plant measurements
- 2,926 seeds
- 1,334 plant specimens
- 319 fungal specimens
- 141 insect specimens
- 5 threatened and endangered species tissue samples

17 of the plant specimens collected in 2015 were new county records, expanding our knowledge of plant distributions.
Living Collections
The living collections at Denver Botanic Gardens are one of the most diverse in North America with seven major collections identified: Alpine, Amenity, Aquatic, Cactus & Succulents, Native, Steppe and Tropical. Individual plants within these collections are grown for aesthetic purposes, education, research and/or conservation efforts. Plants are collected from the wild, received through exchanges and purchased from nurseries and garden centers.

Tissue Culture
Plants in our Living Collections that are difficult to propagate by traditional methods are expanded through tissue culture. In 2015, 13 species were produced and/or experimented in tissue culture, producing over 800 plantlets. These plantlets are supplied to our green industry partners.

Herbaria
Denver Botanic Gardens has two herbaria: The Kathryn Kalmbach Herbarium of Vascular Plants (KHD) and the Sam Mitchell Herbarium of Fungi (DBG). These collections document vascular plants and fungi throughout the Southern Rocky Mountain Region and include small ethnobotany and insect collections (DBGA). In 2015, Gardens’ staff collected plants, fungi and insect specimens in 26 Colorado counties documenting under-collected areas of high biodiversity.

WHERE WE SENT COLLECTIONS IN 2015
Exchanges impact scientific investigations here at the Gardens and across the globe.

887 ACCESSIONS SENT
602 ACCESSIONS RECEIVED

808 Seeds
43 Plants
14 Fungi

Our Collections
Denver Botanic Gardens is an American Alliance of Museums (AAM) accredited museum with two natural history collections (herbaria), seven living collections, art collections and a library.

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Helen Fowler Library
The Helen Fowler Library supports research through access to scientific literature. In 2015, researchers requested a diversity of literature, from recent publications in scientific journals to 200-year-old books held in the Waring Rare Book Room. Working together, library and herbaria staff curated and catalogued hundreds of general interest plant and fungal books stored in the herbarium.

Search Our Collections
Our collection data are accessible 24/7 through data portals.

Herbaria collections are available through SEINet (swbiodiversity.org/seinet) for plants, MycoPortal (mycoportal.org) for fungi, and SCAN (symbiota4.acis.ufl.edu/scan/portal) for insects.

Living collections can be searched through Gardens Navigator (navigate.botanicgardens.org). Collections are also searchable through Botanic Gardens Conservation International (bgci.org/plant_search.php), which includes data from 1,144 institutions.

Library resources can be accessed at www.botanicgardens.org/library.

NEW COLLECTION
Herbaria I Collection of Arthropods
In 2015 we started this collection to discover and document arthropod diversity within the Gardens and to educate about their role in the Gardens and wildlands.

In August, our first corpse flower, Amorphophallus titanum, bloomed. When the male flowers matured, we harvested pollen and sent it to the Chicago Botanic Gardens to facilitate pollination of their corpse flower which bloomed later in 2015. Photo by Scott Dressel-Martin.

Total Accessions as of 12/31/2015

<table>
<thead>
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<th>Category</th>
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<td>DBG (fungi)</td>
<td>17,875</td>
</tr>
<tr>
<td>DBGA (insects)</td>
<td>141</td>
</tr>
</tbody>
</table>

9 fungal species were found in Colorado for the first time in 2015 and are housed at the Sam Mitchell Herbarium of Fungi. They include:

- Agaricus rubronanus
- Russula silvicola
- ++++

Our collection data are accessible through portals.

Herbaria | Collection of Arthropods
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Library resources can be accessed at www.botanicgardens.org/library.

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Outreach

External scientific community engagement
Attended or presented at 16 conferences or workshops in 2015.

Internal scientific community engagement
Hired and trained undergraduate and graduate students, interns and seasonals.

External public engagement
Participated in the Exhibitor Lounge at TEDxYouth@MileHigh which was attended by 2,000+ middle- and high-schoolers.

Internal public engagement
Conducted Science Chats in the Science Pyramid, interacting with over 2,500 visitors in 2015.

External program support
Provided over 250 hours of lectures, interviews and workshops to local radio and TV programs, Garden Clubs, Fungal and Plant Societies and classrooms, as well as partnering with outside organizations to support initiatives.

Internal program support
Provided research and education specimens to Gardens’ staff to facilitate workshops, tours, classes and exhibits.

Publications


Grants & Funding

$159,677 from 7 grants $141,940 from 4 grants

PRESENTATIONS


Krishnan, S. Science and Culture of Coffee: Invited presentation to Bondurant High School as part of the World Food Prize lecture series. 2015. Des Moines, IA.


Global Strategy for Plant Conservation

Denver Botanic Gardens utilizes the five objectives and 16 targets of the Global Strategy for Plant Conservation (GSPC) (www.cbd.int/gspc/programme/guide.shtml) as a guiding framework for conservation activities. Everything we do can be framed within a global context thus making our work relevant beyond our region.

OBJECTIVE I Plant diversity is well understood, documented and recognized
- Visited 43 field sites in Colorado in 2015 to collect and document plant and fungal diversity.
- Published data on the Global Biodiversity Information Facility (www.gbif.org) and iDigBio (www.idigbio.org/portal) portals to ensure our collections are available and accessible to a global audience.

OBJECTIVE II Plant diversity is urgently and effectively conserved
- Continued long-term monitoring of four rare Colorado species involving statistically rigorous, annual sampling of marked individuals in situ to guide management strategies.
- Collected seeds from three species in two counties in collaboration with the Center for Plant Conservation.
- Maintained representatives of more than 150 IUCN Red List species listed at vulnerable, endangered or critically endangered in our living plant collection.

OBJECTIVE III Plant diversity is used in a sustainable and equitable manner
- Provided assistance to complete the master plan for the M.S. Swaminathan Botanical Garden in India. This Garden will play a key role in addressing local agricultural heritage and conservation of crop genetics.

OBJECTIVE IV Education and awareness about plant diversity, its role in sustainable livelihoods and importance to all life on earth is promoted
- Spent over 100 hours in the Gardens’ Science Pyramid educating visitors about Colorado flora.
- Staff collaborated with two botanical illustrators, Benjamin Cardenas and Ilmu Kayama, to create illustrations for publications and to showcase Colorado’s rarest species.

OBJECTIVE V The capacity and public engagement necessary to implement the Strategy have been developed
- Citizen scientists volunteered 289 hours with us through the Rare Plant Monitoring Steward program collecting data to protect rare and federally listed plants.
- Helped organize the 2015 High Altitude Revegetation and Central Rockies Society for Ecological Restoration Conference and Workshop at Colorado State University in Fort Collins, CO.


Krishnan, S. Science and Culture of Coffee: Invited presentation to Bondurant High School as part of the World Food Prize lecture series. 2015. Des Moines, IA.


Krishnan, S. Science and Culture of Coffee: Invited presentation to Bondurant High School as part of the World Food Prize lecture series. 2015. Des Moines, IA.


2015 floristic surveys found *Lewisia rediviva* in Garfield and Hinsdale counties, extending the documented southern edge of its known range by 225 km. Photo by Mike Kintgen.

Thank You to Our Funders

American Penstemon Society
Black Hills Exploration and Production
Borgen Family Foundation
Center for Plant Conservation
Colorado Native Plant Society, Marr Fund
Denver Botanic Gardens Guild
Institute of Museum and Library Services
National Fish and Wildlife Foundation
Five Star & Urban Waters Program
National Science Foundation
Stanley Smith Horticultural Trust
The Garden Club of Denver
US Bureau of Land Management

We gratefully acknowledge the many other individuals who provide financial support for our work throughout the year. Science at Denver Botanic Gardens is also supported with distributed income from Denver Botanic Gardens Endowment Funds. Denver Botanic Gardens is supported by the Scientific & Cultural Facilities District (SCFD).

To keep up-to-date with science at Denver Botanic Gardens, you can sign up for the quarterly Science e-newsletter by clicking “Subscribe” at the bottom of [www.botanicgardens.org](http://www.botanicgardens.org) and selecting “Research and Conservation.”

Photos taken by Gardens staff unless otherwise noted.