DENVER BOTANIC GARDENS

LIVING COLLECTIONS MANAGEMENT PLAN

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October, 2017

Purpose of the Plan

The Living Collections at Denver Botanic Gardens support the Gardens' mission of *connecting people with plants, especially plants from the Rocky Mountain Region and similar regions around the world.* Collections showcase the use of right plants in the right place, educating the public about horticulture in the semi-arid, steppe climate of the Rocky Mountain and Plains regions. The diverse collections ranging from alpine to tropical plants fulfill the mission through education and conservation messages, and by "providing delight and enlightenment to everyone". Adhering to the standards and guidelines articulated in the Living Collections Management Policy, this Plan provides staff taking care of these collections coordinated and uniform direction to assist in the maintenance, expansion, refinement and development of the collections over the specified period of time.

Collections Content

The Living Collections are comprised of seven major collections:

1. Alpine
2. Amenity
3. Aquatic
4. Cactus and Succulents
5. Native
6. Steppe
7. Tropical

In addition to these seven major collections, the living collections also comprises of a growing Bonsai collection (included under Amenity Collection) and two nationally accredited collections registered with the American Public Gardens Association Plant Collection Network – *Quercus* (Oak) collection and Alpines of the World collection.

Guiding Principles

The acquisition and care of the collections will be guided by the Gardens' four core values:

- Diversity
- Relevance
- Sustainability
- Transformation

Review and Revision of the Plan

The Collections Management Plan will be reviewed as needed at a minimum of every five years to assess the implementation of the priorities and activities specified herein and determine measures to overcome challenges in achieving them. Review and revision will be undertaken by the Director of Horticulture and the curator/horticulturist of the specific collection and will be submitted to the Board-level Gardens and Conservation Committee for recommendation to the full Board of Trustees.

Analysis of Living Collections

Since each of the seven collections have unique characteristics, it would be impossible to combine them and perform a single analysis. Hence, each collection has been treated separately and the following addressed for each collection:

a) Description
b) Collections Content
c) History of Collection
d) Justification
e) Strengths
f) Weaknesses
g) Improvements to Collection since 2006
h) Opportunities and Collection Priorities
i) Implementation Strategy (with timeline)
j) Evaluation

Where garden names have been used, please refer to Appendix 1 for the Denver Botanic Gardens map and individual garden location.

1. Alpine Collection

a) Description

The plants in this collection are described as either truly alpine plants or plants that grow in pseudo-alpine habitats, such as rock crevices (chasmophytes) or exposed locations (facultative alpines).

Definitions:

- Alpine: The standard definition when referring to an alpine habitat is the area above the tree line (the tree line is the particular elevation above which trees are not able to grow.) This definition, however, is misleading, as many of the world's mountain ranges do not have a defined tree line. Wikipedia defines alpine habitats as areas where the mean annual temperature is between 34.7°F and 37.4°F (1.5° and 3°C). Another definition of alpine is given in *The Biology of Alpine Habitats* by Laszlo Nagy and Georg Grabherr. "…Alpine environments are found where, along an altitude gradient, natural woody vegetation changes from various lowland and montane forest formations and gives way to dwarf shrubs, various grass-heath, sedge-heath and moss-heath formations and finally to open frozen ground."
- Pseudo alpine: The collective term used in this report when referring to both chasmophyte and facultative alpines.
- Chasmophyte: Chasmophytes are those plants dwelling mainly in rock crevices.
- Facultative Alpine: Facultative Alpines are plants that grow below the tree line in alpine-like habitats and mimic alpine plants in growth habit. An example would be Pawnee Buttes in northeastern Colorado.

b) Collections Content

Denver Botanic Gardens' Alpine Collection is one of the largest in the country with regards to the number of species.

	True Alpine* 2017	**Total RAG** 2017**
Number of Taxa	423	3,517
Number of families	45	134
Number of genera	158	730
Number of species	395	2,837
Living accessions		4,487
Number of accessions (wild collected or nursery grown of known wild origin)	507	629

*True Alpine = Alpine/pseudo-alpine
**RAG – Rock Alpine Garden

Due to the nature of collections, several of the other collections overlap with the Alpine Collection and vice versa; Native, Steppe and Amenity all have some overlap with this collection. Alpines native to western North America overlap with those in the Native

Collection, and chasmophyte and facultative alpines from steppe regions cross over with the Steppe Collection; however, these species need a rocky environment to survive in the garden and they are displayed in the Rock Alpine Garden or a traditional setting for alpines, such as troughs. In 2016 a new Steppe Garden was added with these microclimates in mind. Alpines of cultivated origin, the various *Primula* and *Saxifraga* cultivars, overlap with the Amenity Collection, but are best served in the Alpine Collection.

c) History of the Collection

The Rock Alpine Garden was designed by Herb Schaal of EDAW Inc., and constructed in 1980. At the time of construction, it was the most ambitious rock garden in the United States. Through the years the Alpine Collection has waxed and waned. In the beginning the Rock Alpine Garden was planted with a higher percentage of true alpines. Over time, because of Denver's hot summers, which can be 90°F or more for 50+ days, true alpines have proven to be short-lived. Plants from continental areas similar to Denver have proven to be better candidates for long-term survival in the garden. For this reason, the Denver Botanic Gardens' collection of plants in the Rock Alpine Garden is particularly rich in Central Asian plants, and it is one of the largest collections of Central Asian plants outside of that region.

In 2000-2001 Wildflower Treasures was created and it featured troughs representing select locations around Colorado. Many of these troughs are home to true alpine plants from Colorado's mountains. The troughs were displaced in 2012 when Wildflower Treasures was converted to Le Potager. The troughs were in storage in the nursery until 2017, when many of them were relocated to the Mordecai Children's Garden.

The year 2001 saw the construction of Western Panoramas and specifically the Bristlecone Border, which created a new home outside the rock garden for many native plants from the subalpine and lower alpine life zones. In late 2004 the former Alpine House was converted to a succulent house as it proved to be unsuitable for true alpines. The addition of the Mordecai Children's Garden in 2010 created additional areas for alpine and pseudo alpine plantings.

In 2012 Denver Botanic Gardens' Alpine Collection was registered with the American Public Gardens Association Plant Collection Network and granted national accreditation as "Alpines of the World Collection." At this point in time, it is the only institution in North America recognized for a worldwide collection of alpines. Betty Ford Alpine Gardens in Vail is recognized for its "Alpines of Colorado."

d) Justification

The Alpine Collection is an asset to a wide variety of people, from staff and researchers to the general public. The Alpine Collection as mentioned above holds an immense amount of diversity that in some cases is the most complete display of certain genera in the country outside of private collections. Not only do researchers and staff draw important knowledge from the collection, it is an inspiration and a guide to general visitors, providing a complex example of what thrives in Denver's continental climate. Since 2005 the collection has provided material for several graduate projects, mainly in the area of genetic studies.

Since its beginning, the plant collection in the Rock Alpine Garden has drawn attention the

world over from astute plant lovers. Many visitors travel to Denver Botanic Gardens from outside the state solely to visit the Rock Alpine Garden. In addition to the Rock Alpine Garden, plants belonging to this collection can be found in South African Plaza, the Western Panoramas, Mordecai Children's Garden and Mount Goliath, constituting one of the largest collections of true alpine and pseudo-alpine plants in the country.

Because of its size and established reputation, the Rock Alpine Garden is the most prominent display area for the Alpine Collection. Since its construction the Rock Alpine Garden has been showcasing plants of the Rocky Mountain Region and similar areas of the world. The Rock Alpine Garden was the first garden at Denver Botanic Gardens to showcase such plants. Visitors seek enjoyment year-round from the collection, which features some of the first and last flowers of the season, as well as unique colors, scents and textures throughout the year. The collection has been an educational feature since its inception, not only because of the Gardens' use of natives and plants from similar climates, but because of its experimentation with plants that would otherwise not thrive in Denver's continental climate. For the past 25 years, the Rock Alpine Garden has proven that many plants listed as tender can actually thrive in Colorado. A few examples include: ice plant (*Delosperma*), California fuchsia (*Epilobium*), Matija poppy (*Romneya*), California flannel shrub (*Fremontedendron*) and *Garrya*.

Mount Goliath combines the beauty of a natural setting with the control and comfort of a man-made garden and visitor center. In addition to its one-of-a-kind location, it fulfills the Gardens' mission through its use of plants specifically native to the Mount Evans Massif (a massif is a compact group of connected mountains forming an independent portion of a range). At an elevation of 11,500 feet, this garden provides a suitable home to a particularly rich collection of true alpines, and it is likely the highest public garden in the world.

Mordecai Children's Garden showcases the ecosystems of Colorado from alpine to plains and desert. This garden has become a great site for the cultivation of difficult alpines. The actual alpine area is a green roof; the green-roof media has proven to grow plants very well.

e) Strengths

The Alpine Collection contained in the Rock Alpine Garden is one of the best documented collections at Denver Botanic Gardens with over 20 spiral binders of accession forms and maps detailing the location of plants in the garden as well as the source and date of planting. These notebooks continue to be updated. Data is also recorded in the BG-BASE. The Rock Alpine Garden underwent a major mapping and inventorying session in 2006 and early 2007. Since that time new accessions continue to be mapped.

The collection in the Rock Alpine Garden is especially rich in species of certain genera. Those genera highlighted in **bold** in the table below contain large numbers of true alpines or pseudo alpines, and some cross over into the Steppe Collection. Many genera are found in steppe environments and continental alpine environments - an example of the close evolutionary roots shared by these two environments.

Genus	Species 2017	Taxa 2017
Acantholimon	17	23
Aethionema	11	12
Allium	41	51
Androsace	12	17
Campanula	50	55
Crocus	30	62
Cyclamen	10	13
Daphne	27	50
Dianthus	48	61
Draba	19	22
Ephedra	12	13
Erigeron	22	29
Gentiana	25	45
Geranium	25	40
Helleborus	16	31
Iris	56	129
Penstemon	61	79
Phlox	19	50
Pinus	27	44
Plantago	9	10
Primula	17	33
Salix	28	35
Salvia	34	56
Saxifraga	40	65
Sempervivum	31	65
Stipa	12	12
Veronica	31	41

The collection of *Ephedra*, Turkish *Salvia, Acantholimon* and *Penstemon* are probably the largest of any public institution in this country. The collection also holds collections of *Aethionema*, *Stipa*, *Cyclamen*, *Helleborus*, *Veronica*, and *Daphne* that are comparable with those of the best institutions in the country. Since 2005 these collections have been augmented, making them some of the largest in the country. Sizable collections of *Androsace, Draba, Erigeron, Primula,* and *Salix* have also been added since 2005.

Other strengths as mentioned by outside collaborators:

- Diversity of collections
- Examples of great plant specimens (both mature and rarely seen)
- A well-designed Rock Alpine Garden

f) Weaknesses

- Collections of "traditional" alpine genera, including *Androsace, Gentiana, Primula, Saxifraga,* and *Draba* could continue to be expanded.
- Lack of a properly functioning irrigation system.

- In order to improve standards of collection to include more traditional alpines, additional staffing would be helpful.
- Addition of an alpine house will allow us to grow and display difficult-to-grow specialty alpine plants. This will require backup growing space to provide specimen-quality plants and qualified staff to maintain the collections.
- Labeling has only been moderately updated since 2014 and will continue to be updated.

g) Improvements to Collection since 2006

- The labeling was updated extensively from 2007 to2011.
- New greenhouses were completed in 2010 with a cool house providing a larger area for propagation of alpines.
- In 2012 the collection became a national collection accredited by the American Public Gardens Association Plant Collection Network which strengthen the goals of the collection.
- Several of the conifers mentioned in the 2005 assessment have been pruned or removed. This is assessed each year and several more large conifers have been removed since 2013.
- Greater interpretation was added in 2014 greatly improving the 2005 weakness of lack of proper interpretive materials.
- The general size of the alpine collection has increased since 2005.
- Between 2012-2016 several new areas for the cultivation of more difficult alpines needing specific microclimates were constructed. Four crevice gardens were added and one area of tufa rock.
- The collection of traditional alpines have increased since 2005.

h) Opportunities and Collection Priorities

- Continue to focus on plants appropriate for rock gardens from climates similar to that of the Rocky Mountain West region, with an emphasis on Central Asia, South Africa, the Western United States, and Patagonia.
- Augment the true alpine collection and keep such species in the collection through propagation.
- Continue to augment the collection to include as many species (*hybrids in certain cases*) as possible of the following genera:
  - *Daphne*
  - *Acantholimon*
  - *Aethionema*
  - *Ephedra*
  - *Draba*
  - *Saxifraga*
  - *Androsace*
  - Adaptable species/ hybrids of *Primula*
  - Any additional genera that are underrepresented in public collections or that are of a particular interest.
- Make sure that Denver Botanic Gardens has not only a good collection of species, but attractive displays.

- Continue to acquire species new to cultivation (through the purchase of wild-collected seed or through Denver Botanic Gardens-funded expeditions).
- Continue whenever possible to acquire material with wild-collected data over cultivated material without scientific data.
- In certain cases, acquire hybrids and cultivars that are easier to grow than the true species of certain genera. This is especially true with *Saxifraga* and *Primula*.

i) Implementation Strategy

Denver Botanic Gardens does not have the resources to support the acquisition of a comprehensive collection of any one genus. Hence, the focus will be on maintaining the existing collections and diversifying the collections with plants from various climates similar to that of the Rocky Mountain West region, with an emphasis on Central Asia, South Africa, the Western United States, and Patagonia. This will be achieved by making seed-collecting trips and by purchasing wild-collected seeds from other known sources.

Timeline:

Activity	2017	2018	2019	2020
Update labeling				
Improved irrigation system				
Wild-collected seed purchases				
Secure funding for seed-collection expeditions				
Seed-collection expeditions				

j) Evaluation

Implementation and evaluation of the Collections Management Plan will be overseen by the Director of Horticulture and the Curator/Horticulturist responsible for the Alpine Collection.

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Update labeling	Every species identified at least once in the garden	End of each year compare accession database with the labels displayed	Horticulturist, Manager of Plant Records
Improved irrigation system	A working system in place with very minimal hand-watering		Curator, Irrigation Manager, Director of Garden Operations, Director of Horticulture
Wild-collected seed purchases	Number and kind of species purchased and propagation success	At the end of each year	Curator, Propagator

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Secure funding for seed-collection expeditions	Funding in place at least 6 months before the seed-collection expedition	Every 6 months	Director of Development, Director of Horticulture
Seed collection expeditions both locally and internationally	Number and kind of species collected during each of the collection trips and propagation success of seeds collected	At the end of each collection trip and monitor propagation results monthly	Curator, Propagator

2. Amenity Collection

a) Description

The Amenity Collection is unique because it comprises traditional garden plants of the Rocky Mountain and Great Plains Region, such as lilacs, daylilies, peonies, roses and bulbs. These are plants that aren't necessarily specific to any one growing region or genera, and are found throughout the Denver Botanic Gardens. Amenity plants are showcased with the express purpose of serving the local community, including plant societies, professionals in the green industry and educational institutions and the general public. One aim of the collection is to demonstrate ways to combine local plant palettes for different situations and needs, using a wide spectrum of trees, shrubs, perennials and annuals. Another is to demonstrate the growth cycle of new cultivars and hybrids suitable for a semi-arid steppe climate, while providing information on good cultural practices and aesthetically pleasing design. The collection is flexible, so that it can be adapted to changes in the environment, including in climate, temperature, weather and pest introductions, and to new horticultural techniques. The collection not only serves the Garden's mission of "connecting people with plants," it also "delights and inspires visitors" with relevant and useful information.

b) Collections Content

The collection encompasses a wide range of plant material (genera) that performs outstandingly in the semi-arid climate of our Rocky Mountain and Great Plains Region. It reflects constantly evolving horticultural techniques that conserve water, protect plants, eliminate invasive species, and recycle and conserve organic materials, and therefore contribute to a more sustainable and environmental way of living. By continuously expanding and raising this collection to a higher level, Denver Botanic Gardens remains a leading cultural institution in the United States.

The Amenity Collection is recognized as an example of outstanding stewardship of Earth's resources. Among its celebrated programs: its annual trials of new plants and planting techniques, the Plant Select® program, the Center for Global Initiatives and the Champion Tree preservation program. The extent of the Amenity Collection is difficult to determine due to the transitional nature of the plants; however, the following statistics of notable genera provide some indication.

Genus	**# Species**	**# Taxa**	**Accessions**
Hemerocallis	12	243	259
Iris	101	890	1,262
Iris @ York street	71	547	697
Iris @ Chatfield	25	323	500
Paeonia	18	147	176
Rosa	30	239	290
Syringa	23	97	130
Dwarf conifer	26	99	154
Viburnum	24	44	82
Lavandula	8	57	95

c) History of the Collection

The Amenity Collection has been an ongoing collection (evolving from a conceptual framework to a named collection) since the inception of the Gardens. It has evolved with changes and improvements in cultural practices. Irises and daylilies are among the collection's oldest plants.

d) Justification

It is first and foremost a collection aimed at inspiring and educating residents and visitors in our Rocky Mountain and Plains semi-arid steppe climate, and serving and benefiting the broadest spectrum of gardeners. There is no more direct way to connect people with plants than to demonstrate how plants can be useful and meaningful to them in a variety of situations.

e) Strengths

The strengths of this collection are its relevance and accessibility to a diverse community, and its ability to change and adapt. It showcases new techniques and plant cultivars, and inspires the community.

f) Weaknesses

- Migration of new pests into the Gardens (Japanese Beetle in Rose Garden).
- Still in process of well-documented evaluations.

g) Improvements to Collection since 2006

- Increased number of species/cultivar images entered in BG-BASE, improving quality of content accessible to public on Gardens Navigator.
- Increased number of species/cultivar locations mapped on BG-Map, improving quality of content accessible to public on Gardens Navigator.
- Developed new marketing tools, including blogs, public talks, events and hands-on workshops on cultural gardening practices.
- Expanded involvement with local plant societies, such as the Mountain & Plains Iris Society, Denver Rose Society, Denver Iris Society and Colorado Springs Iris Society.
- Implemented plant evaluation program at Chatfield.
- Entered bloom data of species and cultivars in BG-BASE (with plant locations and images by seasons), accessible to public through Gardens Navigator.
- Plant display labels have been updated to include hybridizers, plant awards, Plant Select introductions and cultivar group information where appropriate.
- Continual accessioning of new collection acquisitions in a timely manner.
- Reevaluation of rose collection before acquiring new varieties with regard to hardiness, disease and pest resistance, and climate changes.
- Developed interpretative signs to showcase local hybridizer varieties.
- Grouped plant displays to showcase locally developed hybrids.
- Added new plant species/cultivars annually to the existing genera in collection, including 42 varieties of Arilbread Iris and intersectional hybrid peonies.
- Added 481 accessions of historic irises from Lancow family historic iris collection to Chatfield.

- Participating in 'Historic Iris Preservation Society Guardian Program' (HIPSGG Program)
- Participated in Rezac Iris rescue in Sydney, Nebraska to add 75 varieties to Chatfield Iris Collection.
- In the process of verifying the new collection of irises at Chatfield
- Verified and organized York street Iris Collection by bed location (Local Colorado bred Iris in north, Wister Medal Iris in east, Dykes Medal Iris in west and historic iris in south).
- In the process of verifying and reevaluating the existing collection of *Hemerocallis* and *Paeonia*.
- Deep evaluation and refining of *Syringa* collection, including removal of redundant specimens, verification of current species and cultivars in the collection and focusing future collections building on rare and unusual species of *Syringa*.
- Received new *Syringa* species through an exchange with the Arnold Arboretum
- Added new *Lavandula* at Chatfield.
- Adding 'own root' roses to Welcome Garden.
- Added and verified a group of locally collected dwarf conifers which are not available in the commercial trade and represent completely unique genetics.

h) Opportunities and Collection Priorities

- Continue to conduct scientific and cultural evaluations of plants best suited to the Rocky Mountain and Great Plains Region and relay this information to the community through onsite interpretation, brochures, classes and outreach.
- Continue to develop outreach opportunities to educate the community on the importance and relevance of this collection.
- Create a horticulture intern project to oversee and organize this collection and provide funds to accomplish this goal.
- Continue expanding the existing collections through new plant acquisitions.
- Adding metadata that will identify the dwarf conifer collection and the lilac collection as non-locational, garden-wide collections to help with plant records, educational and interpretive purpose.
- Continue opportunistic acquisition to enhance the Bonsai collection.

i) Implementation Strategy

To maintain and enhance the Amenity Collection, the Gardens should develop a scientific evaluation process that assesses the suitability of new horticultural varieties and hybrids for the Rocky Mountain and Great Plains Region. The Gardens should model it after Plant Select®'s plant evaluation program, then develop educational programs and interpretation to convey evaluation results to the public through BG-BASE, Gardens Navigator, website and social media.

Timeline:

Activity	2017	2018	2019	2020
Develop protocols for new evaluation program				
Implement evaluation program				
Develop and implement educational program				
Develop and implement interpretation program				

j) Evaluation

Implementation and evaluation of the Collections Management Plan will be overseen by the Director of Horticulture and the curator or horticulturists responsible for the Amenity Collection.

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Evaluation program	Successful procurement of funds and documented results from trials	Periodically, until evaluation program in place; then evaluate results of program at end of each program term	Horticulturist, Director of Horticulture
Education program	Establish programs that communicate results of evaluation	At the end of each year	Horticulturist, Director of Horticulture
Interpretation program	Ensure evaluation program is well interpreted to public and industry	At the end of each year	Horticulturist, Interpretation Coordinator

3. Aquatic Collection

a) Description

The aquatic collection consists of the following sub-collections:

- Hardy waterlily species and hybrids
- Tropical waterlily species and hybrids
- Intersubgeneric waterlily Hybrids
- Past IWGS New Waterlily Competition Entries
- Historical waterlilies (Denver Botanic Gardens' Rocky Mountain Legacy Collection)
- Victoria waterlilies
- Tropical marginal plants
- Hardy marginal plants
- Floating plants
- Aquatic plants native to Colorado
- Wiersema acquisition (species tropical and hardy waterlilies)
- Carnivorous plants

b) Collections Content

Sub-collection	# Families	# Genera	# Species	# Taxa	# Accessions
Hardy Waterlilies	1	1	4	112	162
Tropical Waterlilies	1	1	15	112	145
Intersubgeneric	1	1	1	13	17
Historical Waterlilies (RMLC)	1	1	1	9	25
Lotus	1	1	2	20	24
Victoria*	1	1	1	2	7
Tropical Marginals	22	31	47	73	94
Hardy Marginals	22	33	52	77	153
Floating Plants	4	4	4	4	4
Aquatics Native to Colorado	6	8	8	8	23
Wiersema Acquisition	1	1	7	7	8
Carnivorous Plants	6	12	77	103	133

*Victoria - accessions vary each year, plants composted at end of each summer

c) History of the Collection

Since the summer of 1973, visitors to the Denver Botanic Gardens have enjoyed an extensive waterway that runs throughout the gardens' property. The abundance of water allows for numerous opportunities to display a multitude of aquatic plants from as far north as Alaska to as far south as South America and Africa.

The world's first water gardening society was founded in February 13, 1983, when the Colorado Water Gardening Society (CWGS) was created in a Denver Botanic Gardens'

classroom. Soon after, the International Waterlily and Water Gardening Society (IWGS) was created. Water gardening has grown at a rapid pace ever since, gaining an enthusiastic following worldwide. Denver Botanic Gardens has remained a main force in this movement through programs such as indoor aquatic displays, waterlily trials and an extensive collection of aquatic plant species and hybrids. The summer displays at the Gardens, which include more than 400 waterlilies and 1,000 plants, focus attention on the enduring power of water gardens, especially in a steppe climate.

In 1987, 1997 and 2014, Denver Botanic Gardens and the Colorado Water Gardening Society co-hosted the International Waterlily and Water Gardening Society Symposium. The first ever IWGS New Waterlily Competition was hosted at Denver Botanic Gardens at the 1997 symposium. Waterlilies that Denver Botanic Gardens have named and helped introduce (such as *Nymphaea '*Colorado' and *N.* 'Joey Tomocik') have received international recognition for their excellence. From 2012 to 2015, Denver Botanic Gardens was the venue hosting the IWGS International Waterlily Competition featuring new hybrids from around the world.

d) Justification

The summer displays of aquatic plants are extremely popular and are enjoyed by visitors of all ages. The volunteer contribution of the Colorado Water Gardening Society in support of the water gardens is extraordinary. Every spring, volunteers assist in putting the outdoor displays together and dismantle them in the fall. Accomplished water gardeners from across the world come to see and enjoy Denver Botanic Gardens' renowned collection. Hybridizers, growers and nurseries are extremely interested in this collection, sometimes traveling long distances to photograph and work with the collection. The media, artists and photographers are frequent visitors to our displays. During the summer, interns and seasonals are often trained in water gardening and the care of this collection.

The water gardens and the aquatic collection have made impressive strides in connecting people with plants. CWGS teams with DBG to host a summer Water Blossom Festival where visitors are exposed to the basics and fun of water gardening. Extensive volunteer opportunities provide an opportunity for staff and volunteers to cooperate in mutually beneficial experiences.

Denver Botanic Gardens also teamed with the IWGS to host the organization's annual New Waterlily Competition in 1997 and from 2012-2015. This contest aims to encourage the creation of new and unique waterlily hybrids. The partnership has also allowed the gardens to add brand new waterlily hybrids to the collection, many of which are not on display anywhere else in the world.

e) Strengths

- Expertise allows for the cultivation and over-wintering of a multitude of plants, including both hardy and tropical plants.
- Extensive volunteer help (especially from the Colorado Water Garden Society) provides valuable help in maintaining collections by creating, maintaining and dismantling the massive summer displays.
- Affiliations with reputable nurseries, collectors, hybridizers and the IWGS allow for the

acquisition of quality plants.

- Availability of greenhouse space allows for the cultivation of tropical waterlilies. A refrigerator maintained at 55°F is used to store numerous tropical waterlily tubers.
- Many outstanding plants have been named and introduced in cooperation with leading hybridizers and nurseries.
- Ample pools allow us to showcase the collection.

f) Weaknesses

- Many tropical plants are moved into outdoor displays for the summer. Dismantling the displays, getting the plants into their proper over-wintering locations, and keeping the labels/inventory accurate and up to date is a challenging task.
- Fluctuations in the water system (including draining of the waterways for the installation and removal of art exhibits) creates challenges in keeping the waterlilies healthy and performing at their best.
- Native aquatic plant collection needs to be expanded and diversified.
- Species waterlily collection also needs to be expanded and diversified.
- The knowledge of this collection is limited to one staff person – the senior horticulturist in charge of the collection.

g) Improvements to Collection since 2006

- The International Waterlily and Water Gardening Society's New Waterlily Competition was held at DBG from 2012-2015. Many of the new hybrids entered were donated to DBG.
- The collection of marginal hardy and tropical aquatic plants has been increased in number and diversity.
- Intersubgeneric waterlilies were added to the collection.
- The new senior horticulturist of aquatics was named as the International Registrar for the genus *Nymphaea* in 2013. DBG is working to develop a database of all named *Nymphaea* hybrids in conjunction with the IWGS.

h) Opportunities and Collection Priorities

- Expand and diversify the native aquatic plant and species waterlily collections.
- Scrutinize all procedures in order to avoid duplicate and excess plants, improve labeling system and better utilize allotted greenhouse space.
- Improve educational and interpretive signs with the addition of both permanent and seasonal signage to highlight various aspects of the collection.
- Increase the number of greenhouse tubs in order to produce a higher number of plants.

i) Implementation Strategy

This collection will be reevaluated to prioritize the content of the collection and deaccession duplicate and excess plants on an ongoing basis. The diversity of other taxa that fully represent this collection will be improved. Interpretation of the aquatic and carnivorous displays is also a priority.

Timeline:

Activity	2017	2018	2019	2020
Expand and diversify native aquatic collections				
Reevaluation & prioritization of collection content to eliminate duplicates				
Improve labeling of individual plants in the pond				
Develop and install permanent and seasonal interpretive signage				

j) Evaluation

The overall implementation and evaluation of the collections plan will be overseen by the Director of Horticulture and the Curator/Horticulturist responsible for the Aquatic collection.

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Expand and diversify native aquatic collections	Number of species acquired	End of each year	Senior Horticulturist, Director of Horticulture
Reevaluation & prioritization of collection content to eliminate duplicates	Complete inventory of the collection and deaccessioning duplicate and excess plants	End of each year	Senior Horticulturist, Director of Horticulture, Plant Records
Improve labeling of individual plants in the pond	Number of labels installed each year and success in retention rate	Each spring	Senior Horticulturist, Plant Records
Develop and install permanent and seasonal interpretive signage	New signs in place	Early summer each year as needed	Senior Horticulturist, Interpretation Coordinator

4. Cactus and Succulent Collection

a) Description

The Cactus and Succulent Collection is divided into three sub-collections: Hardy Cacti and Succulents, Non-Hardy Cacti and Succulents and Steppe Cacti and Succulents.

Definitions:
Hardy Plants: For the purposes of this report, a plant is defined as hardy if it is expected to survive three or more years outside in USDA Hardiness Zone 5 with little or no damage.
Non-Hardy Plants: Plants held in indoor collections, rotated seasonally, used as annuals or not expected to survive a full year outside in USDA Hardiness Zone 5 are non-hardy and are included in the Non-Hardy sub-collection.
Steppe Cacti and Succulents: Plants which are usually hardy and native to steppe regions around the world, aligning with our focus on Steppe environs. Plants within this sub-collection may also fall under hardy, or non-hardy. From here on, this sub-collection will be treated within the Hardy or Non-Hardy sub-collections, depending on where they best fit and not described separately.

b) Collections Content

Succulents are generally defined as plants that can store water in their leaves, stems or roots. This definition is broader than what is applied to most succulent collections as it can include many plants, for example: bulbs that are not generally considered succulents. For the purpose of this report, plants included in this collection are those 'generally accepted' as succulents. This includes all members of the following families: *Cactaceae, Agavaceae, Portulacaceae, Aizoaceae, Crassulaceae, Xanthorrhoeaceae* and some members of other families, including *Euphorbiaceae, Asclepiadaceae, Apocyanaceae, Dracaenaceae.*

In the table below, unidentified species have generally been excluded unless otherwise stated – there are less than 60 unidentified accessions in the Cactus and Succulent Collection out of a total of more than 2,000.

	2017 Hardy	2017 Non Hardy	2017 Totals
Number of Taxa	780	743	1457
Number of Families	17	21	26
Number of Genera	94	155	194
Number of Species	435	629	987
Number of Subspecies, Cultivars, Varieties and Hybrids	345	114	470
Number of Accessions (Including unidentified species)	1,536	874	2,408

Hardy Cactus and Succulent Collection :

The aim of this collection is to represent as complete a collection of hardy cacti and succulents as possible. It is difficult to define how complete our current collection is as there is no one resource available stating which succulents are hardy in Denver. There are many plants that have not yet been tested.

Currently the hardy collection has representatives from nine different families. It is unlikely that there will ever be many hardy succulent representatives from *Asteraceae, Euphorbiaceae* or *Fouquieriaceae*. The hardy members of *Dracaenaceae* (*Nolina* and *Dasylirion*), though currently included in *Asperagaceae* in the BG-BASE, have been moved to *Agavaceae* in Flora of North America[1]. For the purposes of this report, they will also be included under *Agavaceae*. This leaves five primary families as a focus for hardy plants: *Agavaceae, Aizoaceae, Cactaceae, Crassulaceae* and *Portulacaceae.*

Non-Hardy Cactus and Succulent Collection :

The aim of this collection is to represent a good cross section of succulents from many parts of the world, and a variety of families for display in the Succulent House and seasonal outdoor displays. These plants are regularly changed in and out of the Succulent House as required.

The Non-Hardy Cactus and Succulent Collection has representatives from 20 families. Though some families, such as *Cactaceae,* have many more representatives than a family such as *Welwitschiaceae* for the indoor collection, they cannot be considered more important. This is partly because the aim of the indoor collection is to show as wide a variety of succulents as possible, *Welwitschia* are plants that most people would rarely get an opportunity to see. Also, in the case of *Welwitschiaceae, Welwitschia mirabilis* is monotypic. Similarly, many of the other families represented only have a few succulent members; in many of these cases, visitors are surprised to find that their common garden plants have succulent relatives.

The Non-Hardy Collection is displayed in the Cactus and Succulent House, as well as in seasonal displays in Marnie's plaza and the Steppe Garden with the backup collection in Greenhouse 8. Space is very limited and this, in turn, limits the number of plants in the collection, in particular large specimens used in outdoor displays. The epiphytic cacti are housed in the Tropical Collection greenhouses, as the conditions are more suitable for them here, and they are used for display with the other tropical plants.

c) History of the Collection

Hardy Cactus and Succulent Collection:

There have been several growth periods for this collection. The first was when *Sedum, Sempervivum* and *Rosularia* were planted early in the Rock Alpine Garden's history. Additionally, an extensive range of hardy plants from South Africa was developed, most of which are now located in South African Plaza and the Steppe Garden. When Dryland Mesa (then called the Xeriscape Garden) was built in 1987, large numbers of *Opuntia* and ball cacti

[1] Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 7+ vols. New York and Oxford.

were added. These persisted fairly well over the next ten years or so, although many of the rarer ones dwindled. In recent years many more cacti have been obtained from several sources, notably Mesa Gardens and Kelly Grummons, in addition to trials of the first giant Y*ucca* and *Agave,* particularly within the Crossroads area.

Non- Hardy Cactus and Succulent Collection:

For several years there was an assorted collection of non-hardy cacti and succulents in the greenhouses. This collection languished for many years due to lack of staff resources. The collection has improved in recent years, resulting in the former Alpine House being converted in 2004 into a display space currently known as the Cactus and Succulent House. In 2010, the new York Street greenhouse complex was completed and the backup collection was moved to Greenhouse 8. In 2013, Greenhouse 8 was reconfigured to make better use of the limited space and poor light for growing cacti and succulents.

d) Justification

The main audience is the general public, many of whom want to learn about low water-adapted plants that can be used in their gardens. Both collections are appealing to the general public, as they can quickly recognize a cactus and because succulents are often the first plants they try to grow at home.

The Colorado Cactus and Succulent Society has grown immensely in membership and popularity in recent years, holding a very successful yearly cactus and succulent sale. The society uses DBG as its home base and looks to the expertise of Gardens' staff to learn more about and source succulents.

The Hardy Cactus and Succulent Collection dovetails the Gardens' mission as many of its plants are from the "Rocky Mountain Region and similar regions around the world". These plants are some of the most xeric plants that can be grown in this region. The non-hardy collection provides an opportunity for visitors to the Denver Botanic Gardens to view a wider range of succulents not often seen in the outdoor landscape. Both the hardy and non-hardy collections capture the attention of visitors. The unusual shapes and textures of the plants provide year-round interest both indoors and out.

e) Strengths

Hardy Cactus and Succulent Collection:

Overall the Hardy Cactus and Succulent Collection is strong and includes a large portion of plants that are hardy in the Denver area. This collection has been steadily increasing in number and quality over the last few years. There is currently a fair balance between species plants and hybrids. We have one of the strongest collections of hardy cacti and succulents in the country, as our climate suits their growth very well.

- Aesthetic qualities: Cacti and succulents provide year-round structure, texture and color to a large percentage of the outdoor gardens at Denver Botanic Gardens. They are generally mixed in with other non-succulents that have similar cultural requirements. The displays effectively demonstrate how to create low-water gardens that are attractive and interesting.
- Specific families: Collections of *Agaveaceae, Aizoaceae, Cactaceae* (particularly

Opuntia, Cylindropuntia, and *Echinocereus*), *Crassulaceae* (particularly *Sempervivum* and *Sedum*) are especially strong, though all have room for further assessment and expansion.

- Plants of known wild origin: Many of the plants in this collection are of known wild-collected origin. This adds value to the genetic diversity of the collection as the plants are as near to the pure species as is possible without contamination from plants from other locations.
- Testing for hardiness: Many plants in the hardy succulent collection were the first to be tested for hardiness in the area. Several plants are probably the largest or only specimens on the eastern slope of Colorado, though this is hard to verify. Since the completion of the Steppe Garden new initiatives in hardiness testing are being developed.
- Native Cacti and Succulents: Currently our Hardy Cactus and Succulent Collection has a very nice representation of our native cacti and succulents, which covers almost every species native to Colorado.

Non-Hardy Cactus and Succulent Collection:

This collection is not outstanding compared to other institutions. This is primarily due to available resources. However, based on the resources available, it is an interesting and useful collection.

- Diversity: This collection is very diverse, with plants from many areas of the world and many plant families. It shows the variety that exists in succulents. There is a good balance between the more common plants that can be bought and grown by the typical visitor, and the more unusual that can only be seen at botanic gardens by most visitors. In recent years, the collection has improved markedly, especially the genus *Aloe.*
- Aesthetic qualities: The Succulent House has year-round interest, with many plants being winter-blooming.

f) Weaknesses

Hardy Cactus and Succulent Collection:

- Documentation of testing: Though the extensive experimentation done with this collection is definitely a strength and the documentation is good for living specimens, better records could be kept of experimentation with hardiness. Specifically, very little data is available (beyond what individual staff members remember) on which plants did not survive and why. This would be useful data in creating a list of things to try in the future.

Non-Hardy Cactus and Succulent Collection:

- Lack of wild-collected specimens: Though a percentage of this collection is of known wild-collected origin, greater integrity could be gained by increasing this percentage.
- Lack of quality indoor display space for year-round display.

g) Improvements to Collection since 2006

- Continued taxonomic work to maintain integrity of the collection
- Developed more display space for the non-hardy collection in Marnie's plaza as a seasonal display during the summer months. Continued to expand Marnie's Plaza display, and change yearly to keep interesting specimens on view to the public throughout the

summer months.

- Refined the Dryland Mesa to make our hardy, native cacti and succulents more visible.
- Expanded networking with local and regional experts.
- Increased number of taxa in Hardy Collection by acquiring the Kelly Grummons hardy cactus and succulent collection in fall of 2015.
- Approval for redesign of Nexus Berm to showcase hardy cacti and succulents.

h) Opportunities and Collection Priorities

Development of Aridarium on West Terrace:

- The West Terrace of the Greenhouse Complex is a possible site for an immersive display of non-hardy cacti and succulents.
- Design with themes in mind such as: Madagascar Bed; African Bed; Australian Bed; Galapagos Bed; Welwitschia in-ground display.
- Don't limit to only cacti and succulents, but include other desert plants to accent the display and educate on arid ecosystems and environs.
- Develop impactful interpretive content related to cultivating cacti and succulents both indoors and out.
- The Nexus Berm re-design was approved in June of 2017. The Nexus Berm will feature a display of hardy cacti and succulents and companion plants. This garden will accent and tie into the Aridarium.

Continue Testing for Hardiness:

- Research and prioritize plants to test.
- Collect plants from communities at higher elevations or from areas where other plants from those areas have already been successful.
- Consider trying to build collections of *Opuntia* from known historical collections, such as Claude Barr's and Mary Ann Heacock's selections. Most of these should be hardy and should be preserved as a collection.
- Research new available hybrids and assess for inclusion in collection; for example, there are many new *Echinocereus* hybrids currently being produced that would probably be hardy.
- Increase communication with other local experts to see what they are growing that is not being grown at Denver Botanic Gardens. Try to have the Gardens act as a central place where information on testing can be recorded. For example, contacts are available that could allow extensive trialing of plants from the Trans-Pecos region of Texas.
- Documentation of unsuccessful plant trials – the hows and whys should be recorded. For example: if a plant rots, this is noted so that the next time it is tried, cultural conditions can be modified.

Taxonomy:

- Plant names are constantly changing and it is not possible to determine which names or sources should be used forever; however, attempts are being made to choose the most accepted names for plants we currently have and to update these fairly regularly.
- Start by finding out which names similar institutions are using, particularly Albuquerque Botanic Gardens, Huntington Botanic Gardens and Arizona Sonora Desert Museum.

Through conversations with the Desert Botanic Gardens and the Arizona Sonora Desert Museum, we've decided to use CITES as the authority for taxonomic changes.

- It should be noted that there is not a taxonomist on staff and that, though plant records and horticulture staff work together on this problem throughout the plant collections, keeping up with changing taxonomy could be a full-time position.

Pursue APGA Plant Collections Network Accreditation for the Hardy Succulents Collection:

- We have one of the best, if not the best, hardy cactus and succulent collections in North America, and it is constantly growing and improving. PCN accreditation would benefit DBG, and help to conserve hardy cacti and succulents for future generations.

i) Implementation Strategies

- The highest priority for this collection is the implementation of a trial program, which will require collection trips to acquire seeds and vegetative materials. Ongoing taxonomic work is also critical to establishing scientific credibility for this collection. Additionally, we need to make a concerted effort to buy wild-collected seed and plants from legally acquired, reputable sources to add to the value of the collection, in terms of aesthetics and conservation.
- In 2017, begin research and visit indoor, arid displays across North America to draw inspiration for implementing a higher quality indoor arid display. The Desert Dome at the Henry Doorley Zoo was visited in Spring of 2017.
- To achieve PCN accreditation, begin thorough review of the hardy cactus and succulent collections to ensure inventory is correct as well as taxonomy. This will be a multi-person effort as the collections are spread through DBG.

Timeline:

Activity	2017	2018	2019	2020
Development and implementation of trial program				
Seed collection expeditions				
PCN Accreditation				
Research and Develop Aridarium Concepts				

j) Evaluation

The overall implementation and evaluation of the Collections Management Plan will be overseen by the Director of Horticulture and the horticulturist responsible for the Cactus & Succulent Collection.

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Development and implementation of trial program	Develop form for uniform evaluation	Every 6 months	Horticulturist(s)
Seed collection	Number and kind of	At the end of each	Horticulturist,

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
expeditions	species collected during each collection trip and propagation success of seeds collected	collection trip and monitor propagation results monthly	Propagator, Director of Horticulture
Taxonomic research	Consistent naming in accordance with International Standards of Nomenclature	Once a year-ongoing	Horticulturist, Plant Records
PCN accreditation	2 years of preparation	Once a year until ready to apply	Horticulturist(s), Plant Records, Director of Horticulture

5. Native Plant Collection

a) Description

The Native Plant Collection at the Denver Botanic Gardens is subdivided and defined as follows:

Sub-collections:
Colorado Native Collection:
Defined as those plants that are known to occur naturally (pre-European settlement) within the borders of Colorado, but not necessarily exclusive to Colorado.

Western North American Native Collection:
Defined as those plants native (pre-European settlement) to other regions of western North America, but not found naturally within the borders of Colorado.

This collection has significant overlap with several other collections, primarily the Steppe, Alpine, and Cactus and Succulent collections.

b) Collections Content

Losses and gains below reflect a tightening of the inventory process. Data for plants long absent from the collections have been removed, while overall diversity has increased.

	Colorado *and* the West	**Other Western Natives (Not in CO)**	**Colorado Endemics**
Number of accessions	3576	1277	193
Number of families	88	80	14
Number of genera	323	226	21
Number of species	735	515	44
*Number of garden hybrids & cultivars	278	246	
Number of accessions of known wild origin	1327	351	155

**Numbers are approximate and vary year to year as displays change.*

The table below shows the families with the most genera and species & subspecies represented from Colorado and western North America (not Colorado)

Family	**Colorado**		**Western North America (not in CO)**	
	Genera	**Species & Subspecies**	**Genera**	**Species & Subspecies**
Adoxaceae	2	4	0	0
Amaryllidaceae[*1]	1	5	1	4
Asparagaceae[*2]	3	9	10	41
Apiaceae	12	16	2	4

Family	Colorado		Western North America (not in CO)	
	Genera	**Species & Subspecies**	**Genera**	**Species & Subspecies**
Apocynaceae*3	2	8	2	6
Asteraceae	60	154	29	47
Boraginaceae	6	16	5	8
Brassicaceae	10	29	5	6
Cactaceae	6	24	14	46
Caryophyllaceae	6	8	3	4
Crassulaceae	2	4	2	6
Cupressaceae	1	4	4	12
Cyperaceae	3	6	3	4
Ericaceae	2	3	2	4
Fabaceae	14	43	9	22
Fagaceae	1	4	2	13
Juncaceae	1	1		
Lamiaceae	7	11	8	18
Liliaceae	4	6	5	10
Onagraceae	4	11	4	15
Pinaceae	4	14	4	24
Poaceae	28	41	7	10
Polemoniaceae	7	25	5	17
Polygonaceae	4	38	2	31
Montiaceae*4	3	5	3	11
Ranunculaceae	9	31	3	11
Rosaceae	18	40	13	14
Salicaceae	2	8	2	3
Saxifragaceae	3	10	4	8
Plantaginaceae*5	3	65	5	68
Totals in 2017		643		240
Previous in 2008		585		228

*1 Previously Alliaceae
*2 Previously Agavaceae
*3 Previously Asclepiadaceae
*4 Previously Portulacaceae
*5 Previously Scrophulariaceae

c) History of the Collection

The Native Plant Collection began in 1961 with the creation of the Gates Montane Garden. This garden was designed to provide Denver residents easy access to a setting similar to that found west of the city in the foothills of the Rocky Mountains near Evergreen. Though not exclusively native, it did include specimens of most of the trees native to Colorado, with some under-plantings of native wildflowers and shrubs. This garden matured over time, but persisted largely unchanged until the mid-1990's when overdue rejuvenation became

imperative. Many non-native and invasive species were removed, and the diversity of the Colorado native collection has improved greatly since then. The garden now also includes a section devoted to the display of plants found in the montane zones of the West outside of Colorado, including the Sierra Nevada and Cascade ranges. For nearly 20 years this was the only representation of native plants in Denver Botanic Gardens. In response to severe droughts, several initiatives began to expand and diversify this small collection in the late 1970's and early 1980's.

Though not considered a "native" garden, the Japanese Garden, begun in 1979, brought over one hundred native ponderosa pines to center stage as integral elements of the design. This was the first of several initiatives that substantially increased our inventory of native plants.

The Rock Alpine Garden, begun in 1979, has featured many of Colorado's true alpines, along with hundreds of alpine species from similar mountain ranges around the world. Many of these are short-lived at this altitude and their presence in this garden is often fleeting. These plantings are augmented by many other species that are well-suited to the rocky, fast-draining soils of the interior West. This collection is treated separately in this document as the Alpine Collection.

In 1983, the creation of the Laura Smith Porter Plains Garden brought a large infusion of prairie natives. Its purpose was to give city dwellers a sample of what Denver had been like a century ago: a wide-open prairie where slight changes in topography, soil and exposure fostered a subtle diversity in native drought-tolerant plant communities. This provides an important frame of reference, especially to newcomers who are not familiar with the climate and conditions of the Colorado Front Range. Thanks to forethought and early work in this effort, the essential elements of this garden still flourish with only occasional intervention.

From 1985 to 1987, these gardens were supplemented with many new plant species. With the subsequent creation of the Dryland Mesa Garden (originally the "Xeriscape Demonstration Garden") the native collections expanded to include many more perennials, shrubs, trees and cacti from the arid uplands of the West. The Dryland Mesa Garden has proven to be an ideal venue for further experimentation with western natives; however limited space here severely limits future trials in this garden.

The Conservation Garden is our smallest native garden, originally created in 1992 as the Endangered Species Garden. It was designed to highlight several rare plants found primarily in Colorado's shale barrens along the Front Range and on Colorado's western slope. This garden currently maintains populations of *Physaria* spp., *Lesquerella* spp., *Penstemon* spp., and *Oxybaphus rotundifolia* - all endangered plants of Colorado. Renovations have increased the available growing space, and aesthetically connected this garden to the adjacent Sacred Earth Garden. Continued collaboration with the Research Department has increased the number of rare plants in the garden, and expanded the interpretation to reflect the work of the Research Department in monitoring, conserving and restoring rare species.

The Ornamental Grass Garden was also created in 1992 to feature many of the most desirable grasses for garden use. This touches on the reality that without intervention, all of Denver

would still be grass-covered prairie, and it underscores the ornamental value of both native and non-native grasses in our cultivated landscapes.

In 1993, the creation of the Dwarf Conifer Garden added yet another dimension to the collection. Dozens of unique dwarf conifers were acquired from Jerry Morris, a local collector. These were produced from grafted "witch's brooms" found on native conifers throughout the West, and they represent a largely unique and unduplicated collection of native germplasm with great potential for horticultural use in arid parts of the West. This collection continues to expand as new specimens are discovered.

The Roads Water-Smart Garden was established in 1994 with a focus on drought tolerant plants from the West and similar regions around the world. This new approach demonstrated the many ways that natives could thrive and add regional resonance alongside plants from central Asia, the Mediterranean, South America and South Africa. This new approach has brought many native plants into the mainstream of horticulture, and the pallet of plants used here continues to evolve.

In 1999 and 2000, the remaining three borders surrounding the UMB Bank Amphitheater in the heart of Denver Botanic Gardens were transformed from annual displays to native gardens. The former annual plantings, while attractive, were indistinct from those one might have seen at any public garden or city park anywhere in this country. These "Western Panorama Borders" feature signature trees of Colorado, and many of the associated grasses, perennials and shrubs found in these native habitats. They also provide a distinctly western "sense of place" in the heart of the Gardens.

In 2001, the existing Native Peoples' Garden was redesigned with a more specific focus on the plants of the Four Corners region, especially the Colorado Plateau. The redesigned garden was named Sacred Earth, and included four areas with distinct natural plant communities and food crop areas, and approximately 150 different plants. Interpretation explains the uses of many of these plants, as well as their relationships to the indigenous people of the region. This was accomplished with the help of an advisory team of Native American community leaders from Arizona, Colorado and New Mexico, regional university staff, and the Horticulture Department at Denver Botanic Gardens.

In 2001, the Wildflower Treasures Garden was created. This was designed as a western interpretation of the traditional trough gardens found in many botanical gardens in Europe. It featured a central plaza with large trough-style containers; each were planted to represent a rare and specialized habitat found in Colorado, and were planted with primarily small and specialized native plants. This arrangement allowed for more successful cultivation and interpretation of these uncommon plants, and included several that are endemic only to remote areas of Colorado. This plaza was surrounded by beds devoted entirely to western native wildflowers. This garden has since been replaced by the Le Potager vegetable garden. However, due to the value and success of Wildflower Treasures, the trough gardens have been retained in the nursery until fall 2017, when many were relocated to Mordecai Children's Garden.

The Crossroads Garden (formerly known as Yuccarama) was developed in 2001 and 2002, and features many of the hardiest members of the Asparagaceae (Agavaceae) family. This includes species of *Yucca, Nolina, Agave, Hesperaloe* and *Dasylirion*—all western natives. This is a dramatic and sculptural display that draws the immediate attention of guests as they enter the Gardens, and emphasizes the use of drought-tolerant native and non-native plants. This garden was expanded during reconstruction of the Welcome Center in 2010.

In 2015/2016, the former AAS Garden was redeveloped as the Steppe Garden, featuring dynamic rock landscapes and a cross-section of plants from the four major steppe regions of the world: South Africa, Central Asia, Patagonia, and western North America. This built upon the existing landscape of the Cottonwood Border, which had already focused on the flora of the Great Plains Steppe. A small portion was also transformed to represent the Intermountain Steppe west of the Rockies. In conjunction with the educational focus of our Science Pyramid, this secures our place as a leading public garden in the display and interpretation of the Steppe biomes of the world.

d) Justification

The majority of our audience lives within the Front Range region of Colorado, and primarily comes from the metro Denver area. However, out-of-state and international guests visit frequently, especially those interested in viewing our unique native collections and observing the naturalistic style in which they are presented. With our broad range of collections and changing displays, we are able to reach a broad range of audiences.

The Native Plant Collection directly meets our primary goal of connecting people with plants, especially the plants of the Rocky Mountain region. We provide a broad range of garden styles with diverse content for visitors to experience, from alpines to plants of the low deserts. While all of our "native" gardens fill a unique niche, due to their central location, the Western Panorama Borders are the most prominent to the visitor. These surround the central amphitheater and are planted in a naturalistic style. They are strongly evocative of our natural western landscapes, yet structured enough that they can inspire visitors to consider similar landscape options in their gardens. This brings the Native Plant Collection to the forefront as the real and symbolic core of our work at Denver Botanic Gardens. Now the adjacent Steppe Garden enhances our message, illustrating the similarities and differences we have with comparable steppe climates around the world.

In addition, Dryland Mesa, Sacred Earth, the Laura Smith Porter Plains Garden and the Gates Montane Garden each showcase specific native habitats and plant communities, providing a broad representation of conditions found in Colorado and the West. Sacred Earth Garden also focuses attention on historical and present-day uses of many native plants by the indigenous peoples of the Colorado Plateau in the Four Corners region. A teaching space is central to this garden, and is used mainly by school groups and special programs.

As one of the few U.S. botanic gardens located in a steppe climate, we have a unique opportunity to feature native steppe plants and plants from similar steppe climates around the world. Continued study and observation of these similar habitats and plant communities expands our collections, promotes collaboration globally and enriches the visitor experience.

e) Strengths

Colorado has 3,430 native taxa found within its borders (Source: Ron Hartman, B.E. Nelson, A Checklist of Vascular Plants of Colorado, Rocky Mt. Herbarium, University of Wyoming, Laramie.) Of these, Denver Botanic Gardens grows 735 (a slight increase from the previous document). The Native Plant Collection exists within gardens that have great aesthetic appeal and strongly evoke images of our natural landscapes. This is one of Denver Botanic Gardens' great strengths, and its diversity is unparalleled in other public gardens of the region.

Collections of *Penstemon, Yucca, Quercus, Pinus,* and the families Cactaceae and Poaceae are especially strong. Ongoing assessment of each family and genus continues to reveal strengths and weaknesses.

Broadly speaking, the Native Plant Collection at the Gardens is considered to be a strong representative collection. As illustrated by the preceding data, the collection includes great diversity, but seldom includes a complete collection of any specific families or genera. Collections cover the entire spectrum, from barely representative to complete collections within a family or genus. Authorities often differ on exact nomenclature, which can alter numbers significantly, particularly in a difficult family such as Cactaceae or Poaceae.

The following table is a sampling of Colorado Natives at Denver Botanic Gardens:

Family	**Genera possible**	**Genera in collection**	**Species, Subspecies and Varieties possible.**	**Species, Subspecies and varieties in Collection.**	**Genus within family with greatest number of species, ssp, and var. - number possible**	**Number in collection**
Asparagaceae	2	3	7	9	*Yucca*---------6	6
Cactaceae	5	6	27	24	*Opuntia*------14	7
Fagaceae	1	1	4	4	*Quercus*-------4	4
Orchidaceae	11	3	25	3	*Platanthera*---7	0
Pinaceae	4	4	12	12	*Pinus*----------6	6
Poaceae	71	27	296	41	*Elymus*------34	2
Rosaceae	24	18	55	40	*Potentilla*----38	7
Plantaginaceae	18	3	131	65	*Penstemon*---70	62

Wild–collected germplasm is especially valuable to our collection, as it usually represents pure species without genetic material from far-off sources. These are plants that have evolved under, and adapted to, local conditions and are potentially better suited for use in regional horticulture. At this time nearly 37% (previously 26%) of our native Colorado collections and 27% (previously 14%) of other western native collections are wild-collected or nursery-grown of known wild origin. The remainder of the collection is nursery-grown and the exact origin is not usually known beyond the nursery source. These are strong numbers, showing a measurable increase in wild provenance and adding to the integrity of the collection. This remains an ongoing goal for this collection.

Of the 135 accepted plants considered endemic to Colorado (occurring only within the state

of Colorado), 44 species have been grown and maintained by Denver Botanic Gardens. The Gardens has significant potential to act as a repository for more endemic, and threatened or endangered plants. These could be used as valuable educational tools for conservation awareness.

The viability of native plants for use in horticulture is a continuing aspect of our research. The Chatfield Trial Gardens, provides the space and opportunity to test uncommon plants, to make improved selections, and to make side-by-side comparisons to plants existing in the trade. This is vital to our relevance in the world of horticulture and contributes to the continued success of the Plant Select® program.

f) Weaknesses

The majority of our native collections have been assembled based on ease of culture and suitability for horticulture, and use by the gardening public. Aggressive plants, or those that require highly specialized conditions or plant associations are less likely to be included. At this time, several families, genera, and groups of plants are very poorly represented, and continue to provide a challenge. Examples include:

- Orchidaceae
- Ferns and fern allies
- Native aquatics

Most of these present some level of difficulty in culture and procurement, or may, in some cases, be illegal to acquire due to endangered status. These are valuable in their own right, interesting to taxonomists, and important to conservationists and researchers. Still, most have little practical application in horticulture and are not considered high priorities for collections at Denver Botanic Gardens. However, ongoing collaboration with the Research Department and governmental agencies continues to make more species available to us. Future efforts may include more of these otherwise unavailable species.

- Hybrids and Cultivars of Native Species

While we list 278 garden hybrids and named cultivars as derived from plants that are native to Colorado, most of these have been selected from other regions where they also occur, especially the Midwest. Some are grown only for seasonal display, so numbers do fluctuate. There is great opportunity to select and name cultivars from our indigenous germplasm, thereby bringing better adapted plants into the market. Plant exploration, breeding and trials are the only way to acquire and introduce such unique material. The Trial Gardens at Chatfield now provide a venue for testing these collections and collaboration with Plant Select® has contributed some funding to support collection efforts.

We have not made much of an effort to conserve native plant seeds in cold storage. Seed storage should become a priority when we are wild collecting seeds for our garden collections.

g) Improvements to Collection since 2006

- Continued expansion of Chatfield Trial Gardens to enable native plant research and selection process.
- Continuing collaboration with Research Department to add at-risk plants to our living collections.

- Continued work in Plant Records has provided a more accurate assessment of our living collections. This includes purging of obsolete information, updating accepted nomenclature, and improved mapping and verification of living plant accessions.
- Work done by the Propagation team continues to expand our knowledge of seed germination protocols, vegetative propagation techniques, and soils composition. This ongoing effort increases our ability to grow and promote species that have traditionally been a challenge, or difficult to locate in the trade, further enhancing the use of native plants in Horticulture.
- The successful publication of the revised and expanded 11th edition of Meet the Natives, completed by Dan Johnson, was released in 2012 and was sold out within a year. As of this document, a reprint is being pursued and once again we will have this popular resource available to the public.
- A new publication is also underway as a collaboration of 10 DBG Horticulture staff and Timber Press: Field Guide to the Wildflowers of the Rocky Mountain Region. This is part of their larger series intended to cover all regions of the US, and our participation in this volume is a credit to our experience and expertise in the scientific and horticultural fields of native plants. Publication expected in 2018.

h) Opportunities and Collection Priorities

- Conduct further in-depth assessment of collection: numerous families and genera remain absent or barely represented in our collection. Ongoing systematic examination of the collection would be a useful tool in determining the direction and potential content of future acquisitions.
- Prioritize future acquisitions: those with greatest potential continue to be sought out and prioritized.
- Expand exploration and wild collection efforts: several western regions will always have exceptional interest and potential as sources of plants suitable for horticulture in Colorado. These include, but are not limited to the following:
    - Big Bend area—West Texas
    - Edwards Plateau—Texas
    - High elevations within Sonoran Desert—Arizona, Mexico
    - High Elevations within Chihuahuan Desert—New Mexico, Mexico
    - Eastern slope Sierra Nevada—California, Nevada
    - Great Basin ranges—Southern/Central Nevada
    - Eastern slope Cascade Range, Blue Mts. and Wallowa Mts.—Oregon
    - Colorado Plateau and Mogollon Rim—Arizona, Utah
    - All of Colorado, especially:
    - Uncompahgre Plateau—SW Colorado
    - High Plains—E Colorado and bordering states
- Continued Trial Garden participation: this is needed to systematically test promising species and selections for future introduction to the horticultural trade via Denver Botanic Gardens' plant introduction program, Plant Select®.
- Initiate a seed storage program to conserve native species.

i) Implementation Strategy

The Denver Botanic Gardens has a strong Native Plant Collection, and expansion of this

collection will focus on conducting further in-depth examination of this collection to analyze the gaps in the collection and prioritize future acquisitions. Ongoing work will include collection trips and use of test plots to select plants with ornamental value to the horticulture trade. Funding will be needed to cover staff time and plant collection trips.

Timeline:

Activity	2017	2018	2019	2020
Collection assessment				
Seed collection expeditions				
Plants entered into trials as acquired				
Wild-collected seed storage program				

j) Evaluation

The overall implementation and evaluation of the collections plan will be overseen by the Director of Horticulture and the Curator of the Native Plant Collection.

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Collection assessment	Assessment completed	Every 24 months	Curator of Native Plants
Seed collection expeditions	Number and kind of species collected during each of collection trips and propagation success of seeds collected	At the end of each collection trip and monitor propagation results monthly	Curator, Propagator, Director of Horticulture
Plant trials	Program in place with documented results of performance of plants in gardens	Every 6 months	Curator, Horticulture Research Associate, Plant Records
Wild-collected seed storage program	Number and kind of species collected and placed in storage	Annual	Curators, Propagator, Director of Horticulture

6. Steppe Collection

a) Description

Steppe Defined: The steppe biome is dominated by grasslands and shrubs that are found on all continents except Australia and Antarctica. It is mostly found in North America, South America, Central Asia and South Africa. Steppe regions have a continental climate and are most often in the rain shadow of larger mountain complexes. Climatically, the extreme cold of winter and conversely, the extreme heat of summer differentiate steppe from other grassland biomes. While not all plants from steppe regions are hardy or reliably hardy, plants in the collection represent the great diversity that occur in each of the regions. Annual plants, manmade hybrids and, plants that come from more temperate areas within the steppe regions will be used to enhance the display. Many plants in steppe regions have been used and moved around by indigenous persons and used for potentially thousands of years. These plants cannot always be traced back to exact distributions but are important in the ethnobotanical interpretation of how humans interact with steppe climates and the plants within.

Sub-collections: Asian Steppe, South American Steppe, African Steppe, North American Steppe

- **Asian Steppe**: plants which are naturally occurring in the vast central region of the Asian continent.
- **South American Steppe**: plants which are naturally occurring in the vast Patagonian Estepa (very few in our collection).
- **South African Steppe**: plants which are naturally occurring in very small areas of Africa, predominantly South Africa, as well as much of the Mountain Kingdom of Lesotho (few in collection).
- **North American Steppe**: plants which are naturally occurring in the shortgrass and midgrass prairie east of the Rocky Mountain complex and the Great Basin region and the Colorado Plateau between the Rockies and the Sierra complex. There are also smaller pocket regions throughout the greater central portions of North America.

b) Collections Content within the Steppe Garden

Number of Accessions	927
Number of Taxa from South Africa	135
Number of Taxa from Central Asia	213
Number of Taxa from Patagonia	121
Number of Taxa unique to planters	82
Number of Taxa in cultivated section	58

Predominant Families of the steppe

- Asteraceae
- Poaceae
- Cyperaceae
- Fabaceae
- Brassicaceae

- Scrophulariaceae/Plantaginaceae
- Rosaceae
- Polygonaceae
- Chenopodiaceae
- Apiaceae
- Ranunculaceae
- Boraginaceae
- Lamiaceae
- Azoiaceae
- Papaveraceae

c) History of the Collection

Rock Alpine Garden

The Steppe Collection at Denver Botanic Gardens finds its origins in the Rock Alpine Garden. Until 1994 and the advent of the Water-Smart Garden, the Rock Garden was the only garden where a visitor could find steppe plants from the other global regions within the Gardens. This garden was a testing ground for many of the successful steppe plants one finds today in other areas of the Gardens. Still, interpretation wasn't available to explain the relationship among the four steppe regions of the world.

Water-Smart Garden

In 1994, the concept of the Water-Smart Garden lead to an increase in use of steppe plants. Water-Smart featured a mix of drought tolerant plants from North America, South Africa, South America, Asia and the Mediterranean. The mix of dryland trees, shrubs and perennials, and the garden's prominent location have made this one of the most important gardens at Denver Botanic Gardens Water-Smart demonstrates a vast array of plant material in a relatively small area that is perfectly suited to this climate. The underlying message is that there are many areas of the world with a very similar climate to that of eastern Colorado and the North American Steppe.

South African Plaza

When the South African Plaza was installed in 2000, it was a showcase of many of the plants brought into Denver Botanic Gardens' collection via several exploratory trips made to the steppes and mountainous regions of South Africa. Among the showpieces of this garden and collection are the raised *Delosperma* plantings. Delospermas are some of the most recognizable species to come to Denver from the African Steppe.

Mordecai Children's Garden

The entry garden, which is on the green roof portion of the garden, is planted to give the feel of alpine tundra. It's mainly populated with steppe plants that are either ground covers or cushion-forming plants. As you progress through the garden, Glorious Grasslands is a choice example of the steppe. Here, the garden blends plants not only from our native steppe, but plants common to Central Asian steppes.

The Green Roof

Green roof plant trials and displays are a natural fit for many of the steppe-growing species.

Lightweight soils and a need for plants adapted to hot, windy conditions in the summer and cold windy conditions in the winter make this garden another focal point of beauty, research, and collection for steppe species.

June's PlantAsia
PlantAsia was designed in 2001, and constructed in 2001 and 2002 by Denver Botanic Gardens staff. The purpose of the steppe area in this garden is primarily to showcase drought-tolerant plants from the steppes of Asia, and educate the public about the parallels between the high steppe of North America and the high steppe of Asia.

Native Gardens
Being the center of the North American Steppe, many of our native gardens are steppe-themed and should be considered as influencing the greater steppe collection. Gardens including the Plains Garden, Cottonwood Border, the Conservation Garden, Dryland Mesa, and Sacred Earth maintain a very clear and central focus on steppe.

The Science Pyramid
The interpretation in the Science Pyramid is based on steppe ecology. The majority of this information is derived from the book authored by Denver Botanic Gardens' staff titled *Steppes: The Plants and Ecology of the World's Semi-arid Regions*. Additional exhibit and interpretation is focused on Denver Botanic Gardens research which includes the study and monitoring of the threatened and endangered species of Colorado. Many of these species grow in Colorado's steppe climate. This in-depth exhibit provided the ground work for creating the Steppe Garden.

The Steppe Garden
Ground broke in November 2015 for a new steppe-themed garden. During the spring and summer of 2016 the initial plantings were made with a grand opening in July 2016. The garden is organized into separate steppe regions of the world. Specific regions are South African summer rainfall, South African winter rainfall, cultivated material from steppe regions, Central Asia including a section specific to shrub steppe, Patagonia, Inter-montane steppe, and great plains steppe as represented by the Cottonwood border within the Western Panoramas gardens. There are also three unique large planters that are dedicated to niche collections within the greater context of the steppe. One planter is dedicated to Living Stones (*Lithops*), associated species and, similar plants from South Africa and Lesotho. Another planter is planted with specialty bulbs and plants from the alpine steppe zone. The third planter is planted with cushion forming plants.

d) Justification
Our audience is primarily from Colorado's Front Range, in addition to many visitors from out of state. Some of our more regular visitors are amateur gardeners who want to learn about gardening and plants. We also have professional landscape designers, botanists, staff from other botanic gardens and researchers visiting from around the world.

Our Steppe Collection fills a need for plants from similar areas of the world on an aesthetic and research level, making a visit to Denver Botanic Gardens unique. In addition, the

collection shares much of the role of being a living collection with other prominent collections. The Native Plant Collection is greatly influenced by the steppe and all of our Front Range, Eastern Plains, Great Basin, and canyon land flora is steppe. Many of the members of the Cacti and Succulent Collections also find their origins, not only in the desert regions of the world but in the cold, windswept steppes of North America and South America and especially in the steppes of South Africa. Families such as Azoiaceae are found mainly in the steppes. Many of the most popular plants in the regional gardening palette are cultivated and bred from plants of the steppe regions, making many of the most beloved members of the Amenity Collection also heavily influenced by and crossover members of the Steppe Collection. Most of the hardy bulb species in the Gardens find their origins in the South African and Asian steppes. The tulip may be the most famous of the cultivated amenity bulbs, mainly parented from *Tulipa gregii*, a species endemic to the steppes of Kazakhstan. Many of the mainstays of our food crops find their origins in the earliest cultivated portions of the Central Asian steppe. Much of the Asian Steppe hosts a similar climatic region to the front range of Colorado. At the Gardens we are displaying these plants to visitors in a variety of ways. In the Water-Smart and Rock Alpine gardens, our ever expanding collection is used in conjunction with native plants, South American plants and South African plants to create year-round color and interest. These gardens have unique design elements and themes that make the plants even more attractive to visitors and more applicable to the home landscape.

The steppe area in PlantAsia is unique in that it only features plants from the high plains of Asia. This garden is unique to Denver Botanic Gardens, and probably to all of North America. This is the single area of the Gardens where we really get the message across about the significance of high Asian plateau flora in relationship to the flora along the Front Range. The Steppe Collection is most important as an interpretive and educational piece to fulfill our mission.

With the addition of the Steppe Garden and the adjacent Science Pyramid this collection is taking a pivotal role in the messaging of the Denver Botanic Gardens. Collection and displays in this garden are designed to showcase the diversity of each of the steppe regions. While the collections are separated by their respective global regions, great emphasis is placed on showcasing how the plants of each region are similar in growth habit, and even share the same genera between each of the regions. While these similarities provide opportunities to interpret and discuss the similarities in the flora it provides an equally important opportunity to showcase the great diversity and differences in each of the regions. The complex and uncertain weather extremes of the Colorado front range make it difficult to grow some species permanently in the ground. To effectively display plants from regions with similar extremes yet more stable weather patterns, some plants are planted in ground and dug up and stored in appropriate greenhouse space for winter. Main components that are indicative to all of the steppe regions are plants that can be categorized into six groups; herbaceous perennials, woody shrubs, bulbs, annuals, grasses, and succulents. This garden will grow and display these plants in an aesthetic, naturalistic style.

e) Strengths

- Quantitative strengths: Given the number of species represented in the collection, there are a high number of families represented. In total, there are 89 families within three

garden spaces. Although many of species listed were originally planted in the Rock Alpine Garden in the late eighties and nineties, the number of accessions has risen. This is due to the construction of PlantAsia and the increase in diversity in the Water-Smart Garden as well as plantings and expansions of Crossroads Garden (Yuccarama), the Mordeacai Children's Garden, the green roof, the Diane Radichel Plant Select® Garden, and the Steppe Garden.

- Adaptability: Since steppe plants have evolved to thrive in climates similar to Denver's, steppe plants often exhibit a propensity to thrive in our gardens. A great majority of steppe plants are tolerant of extended dry seasons, sun and wind, and expand the plant palette for dryland garden design. They are often easy to care for and need little supplemental water. Many of these plants also thrive in mineral rich organic poor soils that are indicative of the Colorado front range. Because of this plants are carefully monitored to avoid excessive potential for invasiveness.
- Aesthetic appeal: This may be the greatest strength of Denver Botanic Gardens' Steppe Collection. The Gardens derive a great aesthetic benefit from plants such as *Eremurus*, *Veronica*, *Acantholimon* and *Tulipa*. These have become signature plants, adding color and, in some cases, winter interest. Many of the plants introduced to the local trade through the Plant Select® program find their origins in steppe regions around the world. Plants including *Delosperma, Diascia,* and *Gazania* from South Africa, as well as many United States steppe natives, such as *Ericameria, Boutolea, Penstemon,* and *Scuttelaria.*
- Interpretive Message: Similarities between the Asian Steppe and Colorado's high plains offer another way to educate the public about other countries as they relate to Colorado. Perhaps it even lends an exotic feel to the steppe of Colorado, Wyoming and New Mexico. Conservation and collaboration with partners in other steppe regions is critical to understanding our sense of place. Until the last few decades, there has been little exploration of plants from steppe climates. With ever-growing pressures to conserve water, finding plants that thrive in our low-water steppe habitat will be increasingly more important.
- Unique with a wide range of potential: This collection is most likely the only one of its kind in North America. This fact, coupled with our Native Plant Collection, sets us apart from other botanic gardens. Given the vast number of untested plants in the Rocky Mountain Region, the Asian Steppe subcollection has incredible potential for growth and research. For example, Takhtajan outlines the Central Anatolian Province as having a species endemism of 30 percent. The Armeno-Iranian province contains unique genera, such as *Acanthophylum* and *Onobrychis*, and many unique species of *Quercus*. This gives us the option of expanding our collection in many different directions.
- Succulents and their importance in the Steppe Collection: The Steppe Garden, completed in 2016, will allow for a significant expansion in the development of the cacti and succulent collection. Constructed of concrete, large sandstone slabs and a fast-draining soil substrate, the Steppe Garden offers augmented planting space and multiple microclimates for appropriate succulents.

f) Weaknesses

- Very small sample of the actual number of species: Our representative collection, in comparison to the large number of species found in the Asian Steppe, is quite small. We continue to grow many of the same plants in a number of gardens. As we begin to

understand, explore, and create partnerships in various steppe regions, we are beginning to broaden our palette. The number of species from South America and Central Asia should be tested in the trial gardens, as well as in various gardens at the York Street site, and more plants could be tested. One major weakness is the relatively small number of grass taxa, particularly taxa that have a potential for aesthetic appeal.

- Invasiveness: Due to the fact that the climate and growing season are so similar, there is a greater potential for plants to be invasive, and great care must be given in their evaluation and outplanting.
- Space issues: We don't have the space to represent some of the larger genera and families. Steppes are vast, sweeping grasslands and they can be challenging to replicate on a small scale.
- Wild Collected: There were collections brought into the gardens in 2010 from an expedition to Kazakhstan. Many of these plants have been germinated and integrated into the various steppe-appropriate gardens. Many of these plants, however, have not germinated, and there is little or no backup material to work with to increase the numbers of species. We have received germplasm from Argentina, though germination and testing will take a few years. There are opportunities over the next several years to join and create collection trips to Lesotho with the intent to provide benefit and informational exchange to local Botanic Gardens as well as to make permitted collections. Many of the existing plants in the collection from South Africa and Lesotho are from purchased material or from undocumented collections before the impetus on obtaining documented collections was enforced.

g) Improvements to Collection since 2006

- In 2009 and 2010, staff made trips to Kazakhstan to explore plant species and to increase the diversity of our Asian steppe collection.
- In 2011 and 2012, staff made trips to Argentina to explore the flora and to develop relationships with contacts to try to gain permission to collect germplasm for the Gardens' collection of South American steppe plants. Working with INTA in Argentina, we finalized a collaborative three-year agreement to collect and test germplasm.
- Research projects, both internally and externally, are relevant to this collection for the stewardship of our native flora, as well as the adaptability of species from other regions. In 2007 Karen Elsner presented her master's thesis, "Overcoming Seed Dormancy in *Glaucium*". Seed collection of some of Colorado's rare plants has produced results and research for journals articles, including K. Wilcox, C. Newlander, Dr. S. Krishnan and M. Bone's 2012 "Germination Protocols for Eight Rare Colorado Native Penstemon Species" in the Bulletin of the American Penstemon Society, 71: 24-35.
- In 2016 the creation of the Steppe garden gave home to many of the collection items that had previously been stored in the greenhouses, or were just held as seed collections. With the instillation of the garden, the steppe collection now has a central location to display plants. This area is also a place to gather and tell about the importance of conservation and how the human element not only shapes the flora of the steppes but brings humans as a species together in efforts of conservation and issues relating to water conservation.

h) Opportunities and Collection Priorities

- More research needs to be conducted on the global steppe sub-collections. It would be

beneficial to determine which plants are most important to the existing collection and which plants need to be acquisitioned to make the collection more comprehensive. It is imperative that we know what we have in our collection and what the future is of the Steppe Collection to promote Denver Botanic Gardens as the leader in steppe flora.

- Staff need to organize collection trips to appropriate regions of Asia. A commitment like this would truly make Denver Botanic Gardens a leader in Asian steppe flora. It would be worthwhile to start collaborative efforts with botanic gardens in Mongolia, Kazakhstan, Pakistan, Turkey, and other states of the former Soviet Union including Iran. Ongoing efforts are in place to work with the government and land managers in Argentina. We have received the first shipment of seeds from INTA in Argentina in which we will work towards developing germination protocols as well as testing for ornamental appeal and potential invasiveness. Work should continue with creating relationships in South Africa and Lesotho. Colleagues at Munich Botanic Gardens have developed a protocol for collecting germplasm in Lesotho including several days of work or service days at the Katse Botanic Gardens.
- The four major steppe regions of the world are found within North America, Patagonia, Central Asia and South Africa. Although succulents are an important part of each region, the South African steppe holds the greatest succulent diversity of all four areas and particular emphasis will be placed on plant material from that country. The following list of steppe regions, families and associated genera represents initial areas of focus in collection expansion:
  - North America
  - Patagonia
    - Cactaceae – *Gymnocalycium, Maihuenia, Maihueniopsis, Opuntia, Pterocactus, Pyrrhocactus*
  - Central Asia
    - Crassulaceae – *Rosularia, Sedum, Orostachys, Pseudosedum, Rhodiola, Rosularia*
  - South Africa
    - Aizoaceae – *Mesembryanthemum, Nananthus, Ruschia, Delosperma, Lithops, Lapidaria, Titanopsis, Aloinopsis, Faucaria, Pleiospilos, Khadia*
    - Asphodelaceae – *Aloe, Bulbine, Haworthia, Kniphofia, Gasteria*
    - Crassulaceae – *Crassula, Cotyledon*
    - Euphorbiaceae
- Hardiness Trialing: Priority for hardiness trialing will be given to succulent material from South Africa and Patagonia, as the majority of material from North America and Central Asia is already known to be hardy in Denver. Currently (2016), hardiness trials have begun on several crosses of *Aloinopsis*, several species of *Lithops* and many other genera in the Aizoaceae family. South African plant material will be trialed in three main locations, the Living Stones Planter (PL3), the South African Summer Rainfall succulent bed (ZAS) and the South African cultivated material bed (ZAC). PL3 consists of three major features: An area that remains uncovered in the winter, an area that is covered with a Plexiglas panel in the winter, and a buried heating cable. Material will be placed both inside and outside the Plexiglas panel in the winter months and backups will be held in a heated greenhouse. For the first winter season (2016-2017) the heating cable was not turned on, but this variable may change for future hardiness trialing experiments. A

digital thermometer is used to record temperature differences inside and outside the Plexiglas panel. Plant material placed in ZAS will have a minimal cover of frost cloth for the winter months. Material placed in ZAC will receive no additional cover, but will have the added advantage of steep grades and very sharp drainage. Patagonian material will be planted without cover, but in microclimates both on the north and south face of large sandstone slabs. Several specimens from each species will be overwintered in DBG Greenhouses as backup.

- South African Plaza**:** The Steppe Garden will absorb all hardy and steppe appropriate plant material from the garden space known as South African Plaza if and when that space is repurposed.

i) Implementation Strategy

In the future, the major focus will be to diversify the collection with wild-collected material from other Asian, African and South American steppe regions. This will be accomplished by organizing collection expeditions to these regions. Test plots will be created to trial these plants for adaptation to our region. Enhanced interpretation will also be a priority for this collection.

Timeline:

Activity	2017	2018	2019	2020
Plan, organize and implement collection expeditions				
Continue greenhouse propagation				
Enhance interpretation				

j) Evaluation

The overall implementation and evaluation of the Collections Management Plan will be overseen by the Director of Horticulture and the curator responsible for the Steppe collections.

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Plan, organize and implement collection expeditions	Funds raised and number of new plants acquired during these expeditions.	End of each trip	Curator, Director of Horticulture

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Enhance greenhouse propagation	Successful propagation of collected seeds and well-documented records.	Every 6 months	Curator, Horticulturist, Propagator
Identify steppe species in other gardens and collections	Review garden inventories and tag species from steppe regions. Implement collection tagging procedure upon accessioning.	Yearly	Curator of Steppe Collection, Plant Records
Enhance interpretation	Put in place new interpretation, providing educational messages to visitors.	End of year	Curator of Steppe Collection, Interpretation Coordinator

7. Tropical Collection

a) Description

Plantings within Boettcher Memorial Conservatory are designed to showcase plant species found in each of the lowland tropical rainforests around the world, as well as cultivated varieties chosen for their exceptional form or color. With hundreds of thousands of tropical plants in the world, it would be impossible to collect, grow and display them all. Botanic gardens typically have limited space, and therefore they must realistically evaluate the facilities they have and which plant groups or families would best serve their institutions' goals and needs. Currently, Denver Botanic Gardens' Tropical Collection contains nearly 3,177 taxa , representing more than 2,375 species from 706 genera and 124 families. The collection has particularly strong representation from Central America and South America. Asian tropicals are also well represented and while some recent accessions have been added, more plant species from Australia and Africa could be included.

While the Gardens' tropical displays encompass a wide range of plant families, over the years several have obtained prominence in our collection. A description of these sub-collections follows.

b) Collections Content

Orchidaceae

It is estimated that well over 30,000 species of orchids exist on Earth and that nearly 70% of those species are epiphytic. A complete inventory and relabeling of the collection (including the addition of barcoded labels) occurred in 2010. This updated data indicated the collection contained 1,435 accessions representing more than 932 species from over 209 genera. This resulted in a slight decrease in accessions and species attributed to the deaccessioning of duplicates during construction, a more accurate inventory and taxonomic changes in nomenclature (lumping and splitting). As of April, 2017, there are 1,829 accessions representing 980 species and 219 genera. These collection statistics do not show dramatic changes in the size of the collection but indicate an improvement in diversity and quality of plants.

The addition of orchids collected by Gardens' donors William and Mickie Thurston turned a few random plants into an important botanical collection. Over the span of many years, the Thurstons, along with noted orchid specialists, made repeated trips to Central America and South America looking for new and unusual plants. Each collection was well documented, herbarium specimens were made**,** and duplicate divisions were distributed to a number of scientific and botanical institutions, including the Gardens. These early additions established an initial focus on several new world genera, including *Encyclia* and *Oncidium,* but over the years the collection has diversified to include representative specimens from around the world, as well as man-made hybrids. The associated materials from the Thurston collection (slides, drawings and journals) have been turned over to the director of the Botanical Illustration program for cataloging and archiving purposes.

The oldest orchid in the Gardens' collection is an Asian *Coelogyne speciosa*, which has been at the institution since 1967. A 2013 survey conducted by the Smithsonian Gardens indicates

that the Gardens has a particularly strong collection of *Encyclia, Stanhopea* and *Coelogyne* orchids as compared to other institutions surveyed. These are definitely genera to continue building upon. Also, our new greenhouses provide expanded capabilities to grow cooler growing genera, such as *Dracula, Masdevallia* and *Pleurothallis*. As of the 2013 review, the more common genus *Paphiopedilum* had been noted as having weak representation. Forty-nine accessions from this genus have been added since that review.

Perhaps the greatest strength of the Denver Botanic Gardens' orchid collection is the number of plants that are from known wild origin. Additionally, the continuous display of flowering orchids in Marnie's Pavilion and the interface of the collection greenhouses and the orangery provide a year-round attraction for visitors. The annual Orchid Showcase exhibit in the orangery has also become a popular attraction and helps drive garden attendance in the slower months of January and February.

Bromeliaceae

Bromeliads are members of a large family of plants native to tropical and semi-tropical areas of the western hemisphere. Often grown as houseplants, they are admired for their colorful, long-lasting flowers as well as their vase-shaped foliage. Among the more recognizable bromeliads are the pineapple (*Ananas comosus*) and Spanish moss (*Tillandsia usneoides*). The Gardens' bromeliad collection was established in the 1970s by a major donation from Mrs. Walter R. Smith of New Orleans and many of the original plants are still in our collection.

Because of their year-round color and interesting growth habit, bromeliads are a particularly appropriate plant family for the Denver Botanic Gardens to focus on. An inventory was conducted in 2010 and reflects dramatic changes in our bromeliad collection. 2013 inventories indicated that we had 178 species representing 26 genera.

Over the past 10-15 years, the bromeliad collection has suffered from continued transitions of caretakers and poor growing conditions. With those issues resolved, the time seems right to rebuild the diversity of the collection. We will focus on rebuilding species diversity and expanding our collection of *Tillandsia*, which do particularly well in our environments. Our April 2017 inventories indicated that the collection is recovering from previous neglect. We now have 421 species representing 43 genera – and increase of 243 species and 17 genera.

Arecaceae

The plant family Arecaceae (sometimes referred to as Palmae) is a diverse and ancient family with 2,500 species in 200 genera confined almost exclusively to the tropics of the world. Palms are an essential part of any tropical collection and Denver Botanic Gardens is no exception. Due to the many members (and being large trees), a comprehensive collection in culture is impossible. Currently the palm collection is one of diversity attempting to grow and exhibit palms that help to convey to the patron, student and volunteer the vast range of palm morphology, anatomy and habits that exist. Some palms of the collection are important in that they represent rarity either in nature or commerce (*Carpentaria acuminata*) and are valuable from a conservation standpoint. Palms, possibly more than any other plant family, are closely associated with a patron's perceptions of the tropics and for that reason are

invaluable to the Denver Botanic Gardens' Tropical Collection. Certain challenges are inherent when keeping a collection of palms. These include limited space to grow large palms, disease, inability to prune palms once they reach the ceiling (possessing a single meristematic zone) and difficulty transplanting certain species. Despite the horticultural challenges of palms, the reward to patrons and staff is immense and is only made better through diligent study, education and interpretation.

Currently, our palm collection contains a number of species that are not suitable for pot culture and do not have a home in the conservatory. We propose gradually eliminating these from our collections and focusing on species more suitable for the conservatory or pot culture.

Araceae

Araceae, much like Arecaceace, is a large and diverse family containing 2,000 species in 100 genera. However, aroids (the common term for the family) are not solely confined to the tropics, with less than 10 percent of the family inhabiting temperate zones of the world. A tropical collection without aroids would be misrepresentative of tropical eco-systems. Denver Botanic Gardens possesses a moderately large and diverse collection of tropical aroids with 123 species from 28 genera. The diversity of growth habits amongst aroids at Denver Botanic Gardens includes epiphytes (*Anthurium scandens* ssp. *pusillum*), terrestrial (*Alocasia* sp., *Colocasia* sp., etc), aquatic (*Lasia spinosa, Pistia* sp.) and vines (*Philodendron* sp). Aroids at Denver Botanic Gardens are currently being expanded and we recently added a number of wild collected accessions shared with us by Missouri Botanical Garden. We hope to continue to develop contacts with other botanic gardens so we can continue to build the diversity of our aroid collection. August 2015 and Sept 2016 saw the first flowerings of *Amorphophallus titanum* at Denver Botanic Gardens. Over 20,000 visitors viewed "Stinky" over a two day period with extended hours and long lines. Pollen from the 2015 blooming was shared with Chicago Botanic Gardens and we have received progeny from that cross. We received pollen from NYBG to pollinate 'Lil' Stinker' and have viable seed on hand at this time. Seed and plants will be shared with other institutions. The blooming of these plants proved to be one of best educational opportunities tied to the tropical collections the Gardens has ever experienced.

Zingiberaceae

The gingers (common term for plants of the Zingiberaceae family) are related to the palms and aroids, all being monocots. However, the geography of gingers, unlike that of the palms and aroids, is isolated almost entirely to tropical Southern and Southeast Asia. China alone contains 216 named species and of those 141 are endemic. The collection of plants in the Zingiberaceae family at Denver Botanic Gardens is of moderate size, representing 22 species in 10 genera, compared with the total in the family of 1,300 species in 50 genera. The collection at Denver Botanic Gardens has been assembled to represent the diversity within the gingers to include such forms as basal flowering, apical flowering, rhizomatous, tuber-forming, mat-forming, and others. Because of space requirements, we are not planning any expansions to this collection at this time.

Begoniaceae
The plant family Begoniaceae is made up of three genera, with the genus *Begonia* holding nearly all of the species of the family with an estimated 1,000 species. The importance of the begonia to ornamental horticultural is immeasurable and thousands of hybrids and varieties having been developed since its introduction into European gardens in 1777. Of the 1,000 species in the genus *Begonia*, Denver Botanic Gardens possesses only 26, with nearly the same number of hybrids. Genera *Hillbrandia* and *Symbegonia* are completely absent from our begonia collection and in the case of *Hillbrandia,* will likely be impossible with the only species of the genus being an endangered species. Because of their popularity as houseplants and their potential usefulness in the conservatory, this is a collection that makes sense to expand upon – especially species begonias.

Ferns
'Fern' refers to any plant in the division Polypodiophyta, which is made up of nearly 30 families with 300 genera containing 12,000 species. However, at Denver Botanic Gardens, like many other institutions, ferns are grouped with other pteridophytes, commonly referred to as fern allies. Fern allies include the lycopods, selaginellas, equisetums and psilotums. Ferns and their allies were the dominant flora 200,000,000 years ago, creating lush forests which would later become the vast coal resources we utilize to power much of our modern society. Today, ferns inhabit nearly all climates of the world, yet it is the tropics that possess the majority of fern species. Denver Botanic Gardens' tropical fern collection, including allies, number 49 species in 22 genera among 13 families, a feeble total when held against the entirety of ferns in the world. A comprehensive collection of ferns at Denver Botanic Gardens is prohibited by space and resources; therefore, expansion of the collection should strive to include aspects of diversity, educational merit, research opportunities and interest to patrons.

Gesneriaceae
Gesneriads are a family of mostly tropical plants (both Old World and New World) that are familiar to many houseplant aficionados. Gloxinias, African Violets, and Streptocarpus are some of the more familiar and showy members of this family. This familiarity and the opportunity for year-round color make gesneriads an appropriate family for the Gardens to collect. There are roughly 80 genera in the Gesneriaceae family, of which the Gardens has 20. This is a collection that could easily be expanded and displayed more effectively. Many accessions in our collection survive fine, but are not exactly thriving. We propose further experimentation to find which genera and species perform best in our conditions and focus on those to build upon in our collection.

Acanthaceae
Like Gesneriaceae, the Acanthus family (Acanthaceae) has many plants that bloom nearly all year. With over 36 species growing in our collections, there is always something in bloom. Additionally, there are non-tropical Acanthaceae growing in our outdoor collections. This provides a great opportunity to connect our hardy outdoor collections to our indoor tropical exhibits. This collection provides splashes of color year-round in the conservatory, but can be weedy and space-consuming. We have no plans to expand this collection dramatically in the coming years.

Other Groups of Importance

The above treatments of plant families and groups denotes their importance as a specific collection of significant size and scope, however some species are important individually and are unable to be grouped as part of a larger collection. Several families at the Denver Botanic Gardens are not extensive enough to be deemed a collection. Despite this condition, efforts should be made to refine these collections to fulfill some of the priorities mentioned in larger collections. Some families that could benefit from detailed refinement are Anacardiaceae, Ericaceae, Urticaceae, Asteraceae, Solanaceae, Asclepidaceae, Rubiaceae, Scrophulariaceae and Piperaceae. Several individuals in the tropical collection should be recognized as heritage plants, having been grown at the Gardens since the inception of the Tropical Collection (circa 1965). These plants include: *Callisia fragrans, Eucharis* x *grandiflora, Dichorisandra thyrsiflora, Cecropia peltata, Cycas circinalis, Calliandra haematocephala, Hibiscus rosa-sinensis* 'Scarlet Giant', *Ficus aspera, Rondeletia leucophylla, Dombeya elegans, Pilea cadierei, Pilea involucrata, and Eletarria cardamomum.* In our collection of tropical plants, some deserve a status of rarity; three plants are currently in this status (*Kokia drynarioides* and *Warszewiczia coccinea*). Finally, two groups -- a species collection of tropical *Nymphea* (known as the Wiersema collection) and epiphytic cactus, both of which are tropical in origin will be covered in the Aquatic and Cactus and Succulents sections, respectively.

c) History of the Collection

Tropical plants have played an integral part in the Denver Botanic Gardens' history and continue to be among the favorite attractions to thousands of visitors each year. Before the first formal garden at the Gardens' York Street site was even completed, plans were underway for the construction of a state-of-the-art conservatory to showcase tropical plant collections in semi-arid Denver, Colorado. In 1962, the Boettcher Foundation donated $10,000 to develop plans for a tropical conservatory and in 1963, donated an additional $1 million towards its construction. As noted by architects Victor Hornbein and Edward D. White in the November 1964 *Green Thumb News*, a botanical garden "…has several functions, including plant research; the exhibition of living plants, among them plants not native to the immediate region." During its construction, these architects and general contractor Gerald H. Phipps developed new and innovative ways to construct what has since become a Denver landmark. As construction progressed, mechanical systems to maintain optimum growing conditions were added, and rock and water features installed. Finally, plants were added under the guidance of Ernest Bibee and in January 1966, the Boettcher Memorial Conservatory was dedicated and opened to the public, greatly expanding the diversity of plants on display at the Gardens. 2016 marked the 50th anniversary of the Conservatory.

Orchids and bromeliads were an important part of Denver Botanic Gardens' early tropical plant collections and in 1981, an additional display greenhouse was constructed at the west end of the conservatory to showcase these plant families. Named in memory of Margaret E. "Marnie" Honnen, Marnie's Pavilion allowed visitors the opportunity to view beautiful tropical specimens that had been hidden behind the scenes for so many years. By the early 1990s, many vital systems in the conservatory were showing signs of decline and had

become unreliable. Valuable plant collections were at risk, so planning began for a major renovation. Along with the architecture firm BIOS, Inc., staff and volunteers began brainstorming new botanical and educational themes, and drawings for the renovation were completed in 1997. Work began in January 1998 with the propagation and removal of existing plants, followed by demolition projects. During renovation, new plants were acquired from around the country. A focus of new acquisitions was to have an ever-changing exhibit with a diversity of flowering trees and shrubs to provide color and changing focal points all year. When the conservatory reopened in the fall of 1998, over 800 species of herbs, shrubs, trees and vines were able to enjoy the lush tropical environment created by improved heating, cooling and humidification systems.

With plants flourishing in the newly renovated conservatory, it became apparent that improvements were needed in Marnie's Pavilion as well. In 2001, planning began to replace the rather formal plant displays in this space with a more naturalistic setting for Denver Botanic Gardens' epiphytic plant collections. The Cloud Forest Tree exhibit opened in January 2003 with a focus on displaying orchids, bromeliads and other epiphytic plants in a manner more closely resembling what one might find in nature. The "tree" is constructed of metal culvert pieces, rebar and Styrofoam that has been covered with natural cork bark. Many of the plants growing on the tree were permanently attached, while others were rotated into the display as they come into bloom.

In 2009, work began on replacing all of the backup collection greenhouses and a total renovation of Marnie's Pavilion. The Cloud Forest Tree exhibit was replaced with the current water features and planters in Marnie's Pavilion. The greenhouses are now visually accessible to visitors and are connected to our outdoor gardens via the Orangery, a space with changeable plant exhibits and a year-round presence of a variety of citrus species and cultivars.

Over the years, the Boettcher Memorial Conservatory and its associated collections have proved invaluable in executing the Gardens' mission of connecting people with plants. The conservatory recreates a natural ecosystem that affords visitors new plants to see as well as an endless wealth of opportunities to learn.

d) Justification

While the visiting public is the primary audience for the Denver Botanic Gardens' Tropical Collection, there are also people interested in tropical plant research, like those from Colorado College and the Denver Museum of Nature and Science who use the collections. Numerous Denver area minority populations have heritage in tropical areas of the world, and so the Tropical Collection has the potential to connect these populations with their heritage.

Tropical plants as a whole are particularly interesting and appealing to the general public, and thus can readily serve as an important vehicle for introducing the plant world to the public and providing delight and enlightenment. This collection provides educational opportunities for indoor gardeners. Recent visitor surveys indicate that the conservatory and Marnie's Pavilion have some of the highest visitation of any gardens at Denver Botanic Gardens. They also have the highest percentage of "excellent" ratings by our visitors.

Education programs, especially youth education, have taken increasing advantage of the conservatory for programmatic use. These programs include Plant Discovery Day, Journey to the Rainforest, and Discovery Backpacks among others.

The world's tropical ecosystems have great importance far beyond their geographical boundaries, and the Denver Botanic Gardens Tropical Collection can help people in this region, most of whom will never be able to visit a tropical ecosystem, learn about these ecosystems and their relevance to people everywhere. A little understood fact is that the Denver area was once in a tropical ecosystem—Rocky Mountain plants were once tropical plants!

e) Strengths

- Strong representation of Asian, Central American and South American tropical species.
- Year-round interest with a diversity of flowering trees, shrubs, vines and foliage plants, providing color and changing focal points.
- Diverse orchid collection with the opportunity to rotate and display orchids as they come to bloom in Marnie's Pavilion, orangery/greenhouse interface and Orchid Showcase exhibit.
- Diverse Bromeliad collection.
- Moderately large and diverse tropical aroid collection.
- A diverse variety of growth forms showcased by the Zingiberaceae collection, including basal flowering, apical flowering, rhizomatous, tuber forming, mat forming, and epiphytic.
- An endless wealth of learning opportunities.

f) Weaknesses

- Limited representation of Australian and African taxa in the Tropical Collection.
- Continued refinement of weak cultivars is an ongoing process.
- The Araceae collection has few wild-collected specimens and this collection also needs to be diversified.
- Interpretation and educational programs do not take advantage of the educational potential provided by a tropical display. New interpretation and educational programs should emphasize conservation, ethnic culture, co-evolution, tropical plant adaptations, etc.
- Lack of voucher specimens and low priority because of limited herbarium space.

g) Improvements to Collection since 2006

- Improvements in diversity of collections – especially Bromeliad collection.
- Continued refinement of collections.
- Completion of Conservatory inventory.
- Relabeling of several collections with barcoded labels.
- Increased interpretation in conservatory (photo-metal signs).
- Completed much delayed maintenance to HVAC systems in conservatory and completed replacement of majority of plexi-glass panels.

h) Opportunities and Collection Priorities

- Refining the collection by culling less desirable and poor-quality hybrids, and diversifying sub-collections**.**
- Continued infrastructure improvements (stairs and pathways).
- Expanding public educational programs so the Tropical Collection is utilized to its full potential and winter visitation increases. Install entry interpretation.
- Staff enrichment through networking and travel.
- Add *Coffea* species to compliment research work of Director of Horticulture.
- Due to lack of herbarium space, expand photo documentation of collection for Garden Navigator.
- Utilize the "grotto" space in Marnie's Pavilion to develop a climate controlled space to display our cool growing orchids.

i) Implementation Strategy

Timeline:

Activity	2017	2018	2019	2020
Refine collections				
Renovate conservatory pathways and stairs				
Develop and install entry interpretation				
Expand educational uses				
Network with other gardens with strong tropical collections.				
Add *Coffea* species to collection				
Expand photo documentation				
Develop a display to showcase cool growing orchids in Marnie's grotto space				

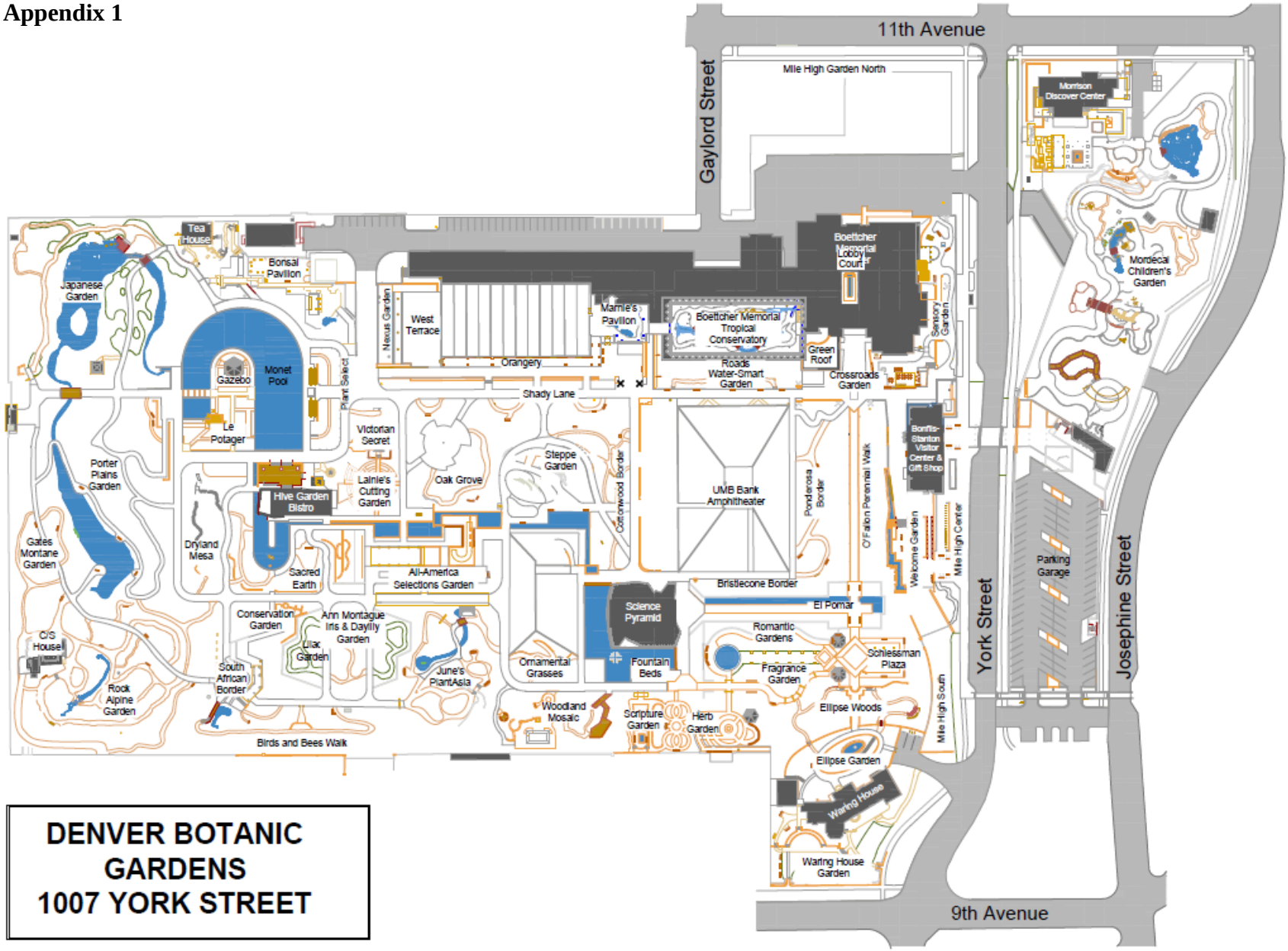
j) Evaluation

The overall implementation and evaluation of the Collections Management Plan will be overseen by the Director of Horticulture and the Curator of the Tropical Collection.

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Refine collections	All plants in displayable condition or on the path of meeting that requirement.	Ongoing	Curator and tropical team members

Activity	Evaluation Procedure	Evaluation Time	Person Responsible
Renovate conservatory pathways and stairs	All facilities in safe condition	As soon as work is completed	CEO, Director of Operations, Director of Horticulture and Curator
Develop and install interpretive entry signs	Signs in place	As budget allows	Curator, Interpretation Coordinator
Expand Educational uses	Define programs	Ongoing	Curator and team members, Education team members
Network with other botanic gardens with strong tropical collections	Each team member visits at least one major botanic garden conservatory and meet with staff.	By end of 2019	Curator, Director of Horticulture
Add *Coffea* species to collection	Identify sources and make arrangements for acquisition of additional species	By end of 2019	Curator and tropical team members
Expand photo documentation	Each team member add photos each year	Ongoing	Curator and tropical team members, plant records team
Develop a display to showcase cool growing orchids in Marnie's grotto space	Funds for exhibit secured and exhibit installed	By end of 2019	Curator, Director of Horticulture, Director of Dedvelopment

Appendix 1



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