Metacollections Management: new approaches for improving living conservation collections

Amy Byrne, Emily Coffey, Patrick Griffith, Jean Linsky, Abby Meyer

Annual Conference
June 5-8, 2023

FORT WORTH DALLAS
NEW HORIZONS
RISING FROM ROOTS
Scan QR code for a resources page
Metacollections Advance Conservation: The DNA Evidence!

M. Patrick Griffith
Montgomery Botanical Center
Metacollection (n.):
A collection of collections.
Metacollection (n.):
A collection of collections.

Why? *To collaboratively steward genetic diversity.*
**But does it work?**

*Metacollection (n.):*
A collection of collections.

*Why? To collaboratively steward genetic diversity.*
Four examples:
Four examples:
1. *Pseudophoenix ekmanii*
Four examples:
1. *Pseudophoenix ekmanii*
2. *Attalea crassispatha*
Four examples:
1. *Pseudophoenix ekmanii*
2. *Attalea crassispatha*
3. *Zamia integrifolia*
Four examples:
1. Pseudophoenix ekmanii
2. Attalea crassispatha
3. Zamia integrifolia
4. Cycas micronesica
Four examples:
1. *Pseudophoenix ekmanii*
2. *Attalea crassispatha*
3. *Zamia integrifolia*
4. *Cycas micronesica*
Threatened by Poaching!

Griffith et al. 2020
Gardens need to coordinate diversity!
Gardens need to coordinate diversity!

Look at the data from *Pseudophoenix*:

Griffith et al. 2020
Gardens need to coordinate diversity!

Look at the data from *Pseudophoenix*:
One garden alone can’t capture enough diversity.

---

Griffith et al. 2020
Gardens need to coordinate diversity!

Look at the data from *Pseudophoenix*:
One garden alone can’t capture enough diversity.

But two gardens working together can!

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Griffith et al. 2020
Gardens need to coordinate diversity!

Look at the data from *Pseudophoenix*: One garden alone can’t capture enough diversity.

But two gardens working together can!

Griffith et al. 2020

- **In situ plants**
- **JBSD legacy plants**
- **MBC legacy plants**
- **JBSD + MBC 2017 plants**
Each garden alone is equally poor.
Each garden alone is equally poor.

A pooled collection does better.
Each garden alone is equally poor.

A pooled collection does better.

Systematic efforts improve further.

Griffith et al. 2020
Each garden alone is equally poor.

A pooled collection does better.

Systematic efforts improve further.

Metacollection is best

Griffith et al. 2020
Even at low collection sizes

Griffith et al. 2020
Even at low collection sizes

Drawing from multiple collections improves genetic capture.

Griffith et al. 2020
GARDENS NEED TO WORK TOGETHER!

Drawing from multiple collections improves genetic capture.

Percent of alleles captured

Number of plants in collection

Even at low collection sizes...
Even at low collection sizes

Drawing from multiple collections improves genetic capture.

**Gardens need to work together!**

... have you heard of a Global Conservation Consortium?

Griffith et al. 2020
To safeguard threatened plant species, botanists and geneticists often utilize seed banks and gene banks to preserve genetic diversity. However, these strategies may not be effective in capturing the full genetic diversity present in wild populations. A new approach suggests that using small, isolated habitat fragments could provide a more comprehensive method for conserving genetic diversity.

In this study, researchers compared the genetic diversity of populations in fragmented habitats to that of undisturbed, continuous habitats. They found that fragmented habitats contain higher levels of genetic diversity due to the unique genetic composition that arises from historical migration patterns and habitat selection.

The results of this study have important implications for conservation strategies. Instead of relying solely on seed and gene banks, conservation efforts should focus on preserving the genetic diversity found in natural habitats. This approach could help ensure the long-term survival of threatened plant species.

Keywords: fragmentation, genetic diversity, conservation, plant evolution.
Four examples:
1. *Pseudophoenix ekmanii*
2. *Attalea crassispatha*
3. *Zamia integrifolia*
4. *Cycas micronesica*
Four examples:
1. *Pseudophoenix ekmanii*
2. *Attalea crassispatha*
3. *Zamia integrifolia*
4. *Cycas micronesica*

Gardens *together* exceed any garden alone!
Four examples:
1. Pseudophoenix ekmanii
2. Attalea crassispatha
3. Zamia integrifolia
4. Cycas micronesica
Attalea crassispatha

A model for “captive breeding” of rare plants
Critically endangered
Critically endangered

Estimated 24 plants left in situ
Critically endangered

Estimated 24 plants left in situ

Seeds were sent to 19 botanic gardens (Timyan & Reep 1994)
Most gardens have no surviving palms.
Most gardens have no surviving palms.

Palms survive at 5 ex situ sites currently:

- Montgomery Botanical Center
- Fairchild Tropical Botanical Garden
- UF TREC Station, Homestead, FL
- USDA Chapman Field
- Singapore Botanic Garden
Most gardens have no surviving palms.

Palms survive at 5 ex situ sites currently:

- Montgomery Botanical Center
- Fairchild Tropical Botanical Garden
- UF TREC Station, Homestead, FL
- USDA Chapman Field
- Singapore Botanic Garden

Roughly 75 plants in cultivation.
Most gardens have no surviving palms.

Palms survive at 5 ex situ sites currently:

- Montgomery Botanical Center
- Fairchild Tropical Botanical Garden
- UF TREC Station, Homestead, FL
- USDA Chapman Field
- Singapore Botanic Garden

Roughly 75 plants in cultivation.

Very few are reproductive.
Most gardens have no surviving palms.

Palms survive at 5 ex situ sites currently:

- Montgomery Botanical Center
- Fairchild Tropical Botanical Garden
- UF TREC Station, Homestead, FL
- USDA Chapman Field
- Singapore Botanic Garden

Roughly 75 plants in cultivation.

Very few are reproductive.

Total species: ca. 100 plants!
Excellent Model for Adapting Zoo Strategies
Excellent Model for Adapting Zoo Strategies

Zoo 1

Zoo 2

Zoo 3

Coordinated Breeding

PMx User Manual
Version 1.0
for PMx v. 1.0.20120115
Every ex situ specimen sampled
Every ex situ specimen sampled WORLDWIDE
Every in situ specimen sampled
Parsed into 3 cohorts:
Parsed into 3 cohorts:

A: Wild
Parsed into 3 cohorts:

A: Wild

B: Founders
Parsed into 3 cohorts:

A: Wild
B: Founders
C: Captive
Parsed into 3 cohorts:

A: Wild
B: Founders
C: Captive

Successive Generations
Ancestry correlates with collecting event
Ancestry correlates with collecting event
Ancestry correlates with collecting event

**Captive Born**

**1991 collection**

**Founders**

**Individual**

**1989 collection**

**Wild**
CAUTION: some potential mislabeled collections
CAUTION: some potential mislabeled collections
Excluded from program!
Reduced diversity each generation!
Reduced diversity each generation!
Reduced diversity each generation!
Solution: optimizing breeding pairs

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Solution: optimizing breeding pairs

Estimates how related each pair is

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Estimates how related each pair is

“Completely” unrelated
Solution: optimizing breeding pairs

Estimates how related each pair is

"Low hanging fruit"

"Completely" unrelated
RECOMMENDATIONS:

1. Targeted Collections Development
RECOMMENDATIONS:

1. Targeted Collections Development

Some wild plants not yet contributing to collections
RECOMMENDATIONS:

1. Targeted Collections Development
2. Coordinated breeding throughout metacollection
RECOMMENDATIONS:

1. Targeted Collections Development
2. Coordinated breeding throughout metacollection

Challenges with phenology, pseudodioecy
RECOMMENDATIONS:

1. Targeted Collections Development
2. Coordinated breeding throughout metacollection
3. Rigorous chain of custody

91327*G
Attalea crassispatha
Arecaceae
Collected from: Haiti
RECOMMENDATIONS:

1. Targeted Collections Development
2. Coordinated breeding throughout metacollection
3. Rigorous chain of custody

Only verified plants should be included!
Goal: unified conservation breeding strategy
Current management practices do not adequately safeguard endangered plant species in conservation collections

Zoe Diaz-Martín1, Jeremie Fran1, Kayri Havens2, William Cleva3, Joann M. Tucker Latina, M. Patrick Griffin1

1. Introduction

In situ collections remain a vital component of plant conservation efforts, but not all species are well represented or protected in these collections. The conservation status of individual species is affected by the interplay of local and global factors, and the genetics of an individual species can be impacted by its habitat, management practices, and other factors. As a result, it is important to understand the genetic diversity of individual species in conservation collections, as this information can be used to inform conservation strategies and improve the effectiveness of conservation efforts. In this study, the genetic diversity of individual species in a specific conservation collection was assessed and the results are presented.

2. Methods

The study was conducted in a specific conservation collection, where the genetic diversity of individual species was assessed using a combination of genetic markers. A total of 50 individuals from each species were sampled, and the DNA was extracted and analyzed using high-throughput sequencing. The results were then compared to previous studies and the genetic diversity of individual species was assessed using a variety of statistical analyses. The genetic diversity of individual species was found to be low, with most individuals showing similar genetic profiles. The results highlight the need for improved conservation strategies to ensure the long-term survival of endangered species.

3. Results

The genetic diversity of individual species in the conservation collection was found to be low, with most individuals showing similar genetic profiles. However, some species showed higher genetic diversity than others, indicating that there is still hope for their long-term survival. The results also highlight the need for improved conservation strategies to ensure the long-term survival of endangered species.

4. Conclusion

The results of this study highlight the importance of conservation efforts and the need for improved conservation strategies to ensure the long-term survival of endangered species. Continued monitoring and research is needed to better understand the genetic diversity of individual species in conservation collections and to inform conservation strategies.
Four examples:

1. *Pseudophoenix ekmanii*
2. *Attalea crassispatha*
3. *Zamia integrifolia*
4. *Cycas micronesica*
Four examples:
1. *Pseudophoenix ekmanii*
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Metacollections secure plant diversity.
Four ex-situ taxa of cycads:
1. Pseudophoenix sargentii
2. Attalea funifera
3. Zamia integrifolia
4. Cycas circinalis

Conservation through collaboration
Four examples:
1. *Pseudophoenix ekmanii*
2. *Attalea crassispatha*
3. *Zamia integrifolia*
4. *Cycas micronesica*
8. The Hurst starch mill in Lemon City, circa early 1900s. Here coontie root was processed into raw starch and shipped, primarily to Key West. Almost every pioneer family, white and black, dug the roots for their own use or for sale. The root once grew plentifully in the pine woods but was harvested to extinction in south Florida. Courtesy Historical Museum of Southern Florida.
8. The Hurst starch mill in Lemon City, circa early 1900s. Here coontie root was processed into raw starch and shipped, primarily to Key West. Almost every pioneer family, white and black, dug the roots for their own use or for sale. The root once grew plentifully in the pine woods but was harvested to extinction in south Florida. Courtesy Historical Museum of Southern Florida.
GENETIC PATTERNS OF ZAMIA IN FLORIDA ARE CONSISTENT WITH ANCIENT HUMAN INFLUENCE AND RECENT NEAR EXTIRPATION

S. Griffith,**, Allen W. Morton,*** Michael Calabro,*** Elisa Guevara,** Kyoji Nakamura, and Javier Francisco-Diaz**

**Department of Botany, Cornell University, Ithaca, New York, USA, \( ^* \)Center for the Americas, Arizona State University, Tempe, Arizona, USA, and \( ^* \)University of Miami, Coral Gables, Florida, USA

Editor: Jennifer Ernst

Griffith et al. 2022
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Widely Grown in Public Gardens
Can this species provide a model for cycad metacollections?
Can this species provide a model for cycad metacollections?

YES
Genetic capture by metacollection: *Zamia integrifolia*
Genetic capture by metacollection: *Zamia integrifolia*

- In situ wild plants
Genetic capture by metacollection: Zamia integrifolia

- In situ wild plants
- Lotusland
- UC Berkeley BG
- Fairchild BG
Genetic capture by metacollection: *Zamia integrifolia*

- In situ wild plants
- Lotusland
- UC Berkeley BG
- Fairchild BG
- Marie Selby BG
- Key West Trop. For. and BG
- Huntington
- Naples BG
- Harry P. Leu BG
Good capture of genetic diversity!
Good capture of genetic diversity!
Especially if a single collection is lost.
Four examples:
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A big group of gardens can steward big diversity.
Four examples:
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a current extinction risk
2000: Dominant Canopy Species on Guam!
2000: Dominant Canopy Species on Guam!
2001
2002
2003: Invasion by Cycad Scale Insect
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2000: Dominant Canopy Species on Guam!

2001

2002

2003: Invasion by Cycad Scale Insect

2004

2005: Monitoring began

2006

2007

2008

2009

2010

2011

2012

2013

2014

2015

2016

2017

2018

2019

2020

2021

2022

2023
2000: Dominant Canopy Species on Guam!
2001
2002
2003: Invasion by Cycad Scale Insect
2004
2005: Monitoring began
2006: 100% seedling mortality
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
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2023
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2001
2002
2003: Invasion by Cycad Scale Insect
2004
2005: Monitoring began
2006: 100% seedling mortality
2007: Targeted ex situ collections made.
2008
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2023

Montgomery Botanical Center Guam 2007 Expedition
Cycas Micronesica Populations Collected by Thomas Marler

- AAFB
- Hatchery
- IJA
- Lam Lam
- Pagat
- Racetrack
- Ritidian
- Tagachang
- Existing populations at MBC

* Numbers represent number of mother plants sampled for seeds.
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2023: YOU ARE HERE

Question:
How effective is this?

Can targeted conservation metacollections safeguard a species in crisis?

In this context?
A broader metacollection exists

Several “V.I.P.s” from before the scale invasion!
Preparing the specimens
Preparing the specimens

To be continued . . .
Four examples:
1. *Pseudophoenix ekmanii*
2. *Pseudophoenix sargentii*
3. *Zamia integrifolia*
4. *Cycas micronesica*
Four examples:
1. *Pseudophoenix ekmanii*
2. *Pseudophoenix sargentii*
3. *Zamia integrifolia*
4. *Cycas micronesica*

Can targeted metacollections prevent extinction?
Now, back to that **Original** Question:

**But, does it work?**

**Metacollection (n.):**
A collection of collections.

**Why?** *To collaboratively steward genetic diversity.*
But, does it work?
But, does it work?

Yes!
But, does it work?

Yes!

The DNA Evidence!
TOWARD THE METACOLLECTION:
Coordinating conservation collections
to safeguard plant diversity

THE LARGEST FORCE FOR PLANT CONSERVATION

Worldwide, over 3,000 botanic gardens maintain at least one-third of all known plant diversity. The collective conservation power of botanic gardens is essential to stop plant extinction. Networks allow gardens to coordinate efforts to save endangered plants. The global web of botanic gardens is the world’s largest force for plant conservation — as long as it is well coordinated.

Freely available at:
bgci.org
montgomerybotanical.org
Thank You
Thank You
What Metacollection can you envision?
What will it accomplish?
What Metacollection can you envision?
What will it accomplish?

Discuss for 10 minutes!
Global Conservation Consortia: Multi-sector consortia delivering integrated plant conservation on a global scale

Emily E. D. Coffey, Dan Crowley, Jean Linsky, M. Patrick Griffith, Vanessa Handley, Murphy Westwood, Silvia Alvarez-Clare, Amy Byrne, Abby Meyer, Olivia Steed-Mundin, Jo Wenham, Emily Beckman Bruns, Emily Schumacher, Sean Hoban, Emma Spence
Collective conservation power of botanic gardens can stop plant extinction

A single plant can contribute to conservation, but many plants are needed to capture significant genetic diversity and safeguard

Networks allow gardens to coordinate efforts to save endangered plants
American Public Gardens Association Multisite Collections, BGCI’s Global Conservation Consortium and the CPC National Collection are Metacollections!
Botanical Gardens Conservation International

BGCI’s mission is to mobilize botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet.

3,700 botanic gardens worldwide
60,000 botanical experts
1 billion visitors
Botanic Gardens Contribute to Plant Conservation

Integrated Plant Conservation

**In situ**
- Plant species managed and monitored in natural habitats
- Restoration
- Collection

**Ex situ**
- Plant species curated outside of natural habitats

**Research**
- Reproductive biology, genetics, ecology

**Horticulture**
- Propagation protocols, cultivation for reintroduction

**Education**
- Interpretation, training, awareness-building

**Germplasm**
- Seed bank
- Cryopreservation
- Micropropagation

**Living Plants**
- Conservation collections
- Reference collections
- Display specimens

**Metacollections**

BGCI
Plants for the Planet
Our Aim

No tree species becomes extinct

1. **Prioritise** which tree species are in need of conservation action, where action is required, and which threats need to be addressed

2. **Plan** conservation action for species, sites, and at the national, regional and taxonomic-group levels

3. **Act** to mitigate threats and deliver integrated conservation for individual species and through multi-species approaches

4. **Monitor** the impact of our own programme and tree conservation action globally
BGCI technical programs

- Red listing
- Tree conservation
- Seed conservation
- Ecological restoration
- Plant health and biosecurity
- Education
Setting the scene:

Global Tree Assessment
Global Trees Campaign

- Cataloguing the world’s trees
- Prioritising tree species for conservation action
- Taking direct conservation action working with local partners
- Zero tree species extinctions
Global Conservation Consortia (GCC)

- One in three tree species are threatened with extinction
- Scale-up tree conservation via GCC’s
- Utilizing specialist knowledge of target taxa
- Conserve trees where the need is greatest
- *In situ* and *ex situ* work focused in centres of diversity
- To be led by institutions based in centres of diversity

...to mobilise a coordinated network of institutions and experts to collaboratively develop and implement comprehensive conservation strategies for priority threatened plant groups
GCCs

Taxonomic groups selected for GCC meet several of the following criteria:

- **Highly threatened** groups
- **Technically challenging to grow**
- **Technically challenging to manage** (e.g. exceptional species that cannot be seed banked)
- Plant groups with diversity centres of **low capacity** → opportunity to build capacity
- Plant groups with a **distribution that spans many regions** → requires coordination
- **Plant groups overlooked by other sectors**
- Plant groups **already prioritised in the botanic garden sector** → leverage momentum
- Plant groups that are **keystone species** in biodiversity hotspots
Current Consortia

- Global Conservation Consortium - Acer
- Global Conservation Consortium - Cycads
- Global Conservation Consortium - Dipterocarps
- Global Conservation Consortium - Erica
- Global Conservation Consortium - Magnolia
- Global Conservation Consortium - Nothofagus
- Global Conservation Consortium - Oak
- Global Conservation Consortium - Rhododendron
GCC Objectives

• Establish and foster a network of experts
• Identify, prioritize species of greatest conservation concern
• Develop coordinated ex situ collections of conservation value
• Undertake and facilitate applied research
• Ensure that threatened species are conserved in situ
• Build capacity of in-country partners in diversity centres
• Increase public awareness and engagement
• Raise funding to scale-up conservation action
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Accession level data

Develop coordinated *ex situ* collections of conservation value

- Accession level data gathering
- Gap Analysis
- Pedigree tracking with PMx
Global Conservation Consortia

Collectively coordinated by BGCI, the Global Conservation Consortia (GCC) aim to mobilise coordinated networks of institutions and experts to collaboratively develop and implement comprehensive conservation strategies for priority threatened plant groups. Each consortium functions within the structure shown.

Learn more at: http://globalconservationconsortia.org
GCC Website

- Consortium-specific materials
- News and events
- Funding opportunities
- Current consortia activities

www.globalconservationconsortia.org
GCC Website

• Metacollections Resources
Join the GCC!

Affiliates

The first step for anyone keen to participate in a Consortium is to sign up as an Affiliate for each Consortium of interest. Additional roles (Species Stewards and Steering Committee Members) will then be invited in consultation with the Lead Institution for each Consortium.

Consortium Affiliates may or may not be officially associated with a botanical institution, and do not hold a formal role in a Consortium. Affiliates commit to the Statement of Intent, receive communications about consortium activities, and may support, collaborate, or advise on any Consortium activities in coordination with the Consortium Steering Committee and/or Species Steward(s), including but not limited to:

- Scouting or collecting trips;
- Population monitoring;
- Research;
- Taxonomic work;
- IUCN Red List assessment compilation or review;
- Ex situ conservation projects (e.g. metacollection management and development);
- In situ conservation projects (e.g. reintroduction, habitat management, invasive species removal);
- Fundraising, advocacy, and outreach.

Join as an Affiliate

Species Stewards

Find out more
GCC Coverage (so far)
Current GCC

• 259 Affiliates in 44 countries

• Sharing knowledge and capacity for effective conservation

• Examples from GCC for Oak, Magnolia and Cycad
GCC Coordinators are critical to success
Everyone has a role to play!
**Plant Collections Network**

**Mission:** Coordinate continent-wide approach to plant germplasm preservation among public gardens & promote standards of excellence in plant collections management

**Developed in collaboration** with USDA Agricultural Research Service and US National Arboretum since 1995

Slides provided by Pam Allenstein
Application & Peer Site Review

- High Priority, Garden-Defined Collection
- Written Application for Accreditation
- Administrative Review by Network Manager
- Site Visit by Peer Reviewer
- Written Site Evaluation with recommendation
- Nationally Accredited Plant Collection™ recognition

Slides provided by Pam Allenstein
Criteria for Plant Collections Network Participation

- APGA Member
- Active Collections Management Program
- Collections Policy & Collection Development Plan
- Designated Curator
- Access to collection
- Long Term Commitment to Collection
- Disaster Plan for Living Collections & Records
Current Multisite Collections

- Large taxonomic groups
- High horticultural & economic significance
- Diversity sufficient to encourage preservation across a wide range of geographic and climatic conditions in North America

Acer  
Quercus  
Magnolia  
Cycad
Interested in Applying to Accredit Your Collection?

See our website for more info:
https://www.publicgardens.org/programs/about-plant-collections-network

Contact Pam Allenstein:
PAllenstein@publicgardens.org, ph: 610-708-3015
Thank you

Join the GCC network!
BREAK
BGCI: Securing plant diversity for the well-being of people and the planet
2023 CPC Annual Meeting
Abby Meyer, BGCI-US
The global botanic garden community

3,500 gardens • 30% known plants • 60,000 technical experts • 1 billion visitors
Metacollections
Griffith et al. (2019)

**METACOLLECTION** (n.). The combined holdings of a group of collections. For gardens, metacollections are envisioned as common resources held by separate institutions but stewarded collaboratively for research and conservation purposes. Networking multiple collections into a single metacollection increases potential coverage within a group, allows broader access to greater diversity, dilutes risk of loss, and can reduce maintenance costs. The American Public Gardens Association’s Multisite Collections\(^2\), BGCI’s Global Conservation Consortia\(^3\) and the CPC National Collection\(^4\) are established examples of metacollections. Like any collection, a metacollection can be of any scope or taxonomic level.
• Conservation groves
• Germplasm backup

• Climate suitability
• Early detection
• Isolation
Botanic gardens are rising to meet global challenges

• Greater conservation commitment
• Increased coordination
• Increased information sharing

Griffith et al. 2019 recommendations:
• No one site can (or should) hold all ex situ material of a given species; a coordinated *metacollection* model is needed
• To ensure high conservation value, living collections should collectively capture maximum wild genetic diversity
BGCI Data Tools: Explore, Collaborate, Share

New tools

- **BGCI PlantShare**: Responsible exchange of plant material for conservation
  - [https://plantshare.bgci.org/](https://plantshare.bgci.org/)

- **Climate Assessment Tool**: Check suitability of trees in predicted future climate scenarios
  - [https://cat.bgci.dev/](https://cat.bgci.dev/)

- **Index Seminum**: Exchange of seeds between organisations
  - [https://indexseminum.bgci.org/](https://indexseminum.bgci.org/)
# BGCI’s Programs

<table>
<thead>
<tr>
<th>Prioritizing</th>
<th>Planning</th>
<th>Acting</th>
<th>Monitoring</th>
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<tbody>
<tr>
<td>GTA Global Tree Assessment</td>
<td>BGCI Data Tools</td>
<td>Global Tree Conservation</td>
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<tr>
<td>GCC Global Conservation Consortia</td>
<td>ERA Ecological Restoration Alliances for Biodiversity Conservation</td>
<td>GSCC Global Seed Conservation Challenge</td>
<td>IPSN International Plant Seed Network</td>
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The only global database of the world’s botanic gardens, with information on 3,363 institutions worldwide.
Post-2020 GSPC

Global Partnership for Plant Conservation

• Maintain visibility of GSPC and align with UN Global Biodiversity Framework
• Continue advocacy for the GSPC with key partners and countries
• Promote implementation among partners
• Focus attention on plants in a ‘crowded’ biodiversity arena
PlantSearch Pedigree data

2019–2023 build and refine

• Serve as the species library for Pmxceptional
• Support ex situ gap analysis and conservation planning
  Genetic diversity management
  Demographic stability
  Material backup
  Acquisitions/Transfers

Priorities for botanic gardens:
• Pedigree data standards
• Data accessibility
Entry to Pedigree Module is via an institution’s Taxa List. Selecting an individual taxon allows users to create and manage accessions and/or pedigree records for that taxon.
Viewing pedigree records for a selected taxon. Records can be sorted by columns, and column display can be customized.
Accessions data upload example

BGCI’s Index Seminum tool

Gap analysis methodologies for metacollection management

Jean Linsky
Coordinator of the Global Conservation Consortium for Magnolia
Metacollections

• Data management

• Prioritizing species for focus & understanding gaps

• Collections decision making
Metacollections

• Data management

• Prioritizing species for focus & understanding gaps

• Collections decision making

‘increase coverage within a group & access to greater diversity while diluting risk of loss & reducing maintenance costs’
Gap Analysis - A growing practice


Gap Analysis

A process that identifies differences between the current state and the ideal state, and steps needed to bridge the ‘gap’.
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A process that identifies differences between the current state and the ideal state, and steps needed to bridge the ‘gap’.
Value of conservation gap analysis

Systematically determine priorities and best next-steps
Match needs with resources, and resources with needs
Identify opportunities for collaboration
Conservation Gap Analysis
Methodology

- **Scope refinement**
  - Methodologies applied to multiple taxa and regions

- **Literature review & Surveys**
  - Compiling *ex situ* & *in situ* data

- **Mapping & Spatial Analysis**
  - Geographical & ecological

- **Final Analysis & Prioritization**
  - Species level analysis
  - Comparison
Conservation Gap Analysis
Methodology

Welcome! Here we provide conservation gap analyses for a subset of native North American fruit and nut tree taxa that are traditional foods and/or wild relatives of important agricultural crops, also known as crop wild relatives.

These gap analyses include metrics for both ex-situ conservation (presence in botanic gardens and genebanks) and in-situ conservation (presence in protected areas). Of the 75 taxa we analyzed, with any urgency priority for conservation, 59% are high priority, and 16% are low priority. These results highlight the value need to increase conservation efforts for these important taxa. This includes increasing their representation in botanic gardens and genebanks as well as enhancing their protection in natural habitats.

This work was led by Emily Beedeman-Bruns, Celine Khoury, Nan McCarry, Abby Mayer, Ray Simes, and Emily Vannestray, and funded by the United States Botanic Garden. Emily Beedeman-Bruns was also supported by NSF #0820833 #1244758. Additional thanks to San Diego Botanic Garden, Botanic Gardens Conservation International – US, The Morton Arboretum, and Missouri Botanical Garden for providing organizational support.

March 2023
Conservation Gap Analysis
Methodology

North American Fruit & Nut Relatives Workgroup

Welcome! Here we provide conservation priorities for native North American fruit and nut relatives and their wild relatives of important foods and/or wild relatives of important crops.

These gap analyses include metrics for both ex situ conservation (geneticbanking) and in situ conservation (presence in protected areas and priority for conservation). Seeds are high priority, and this analysis highlights the value of increasing conservation efforts by increasing their representation in botanic gardens and general protection in natural habitats.

This work was led by Emily Backman Bruns, Claire Hessburg, Emily Yanchey, and funded by the United States Botanic Garden Conservation International - US, The Morton Arboretum providing organizational support.
Conservation Gap Analysis
Methodology

Welcome! Here we provide conservation status assessments of native North American fruit and nut tree species and their wild relatives of high priority importance. This work was led by Emily Beckman Bruns, Chris Kexo, Natalie Wood, and Emily VanEtten, and funded by the United States Botanic Garden.

March 2023
Conservation Gap Analysis Methodology

Welcome! Here we provide conservation of native North American fruit and nut tree foods and/or wild relatives of important known as crop wild relatives. These gap analyses include metrics for both in situ conservation genetics and ex situ conservation (presence in protected areas). High priority for conservation. stakeholders are high priority, and highlights the value need to increase conservation efforts. flere for increasing their representation in botanic gardens and gene protection in research habitats.

What is your garden’s mission? How do you know if you are achieving it?

Conserving, curating, and showcasing the world’s botanic diversity is a monumental challenge. Botanic gardens must make careful curatorial decisions to have the greatest impact. Fortunately, tools and approaches are available to help with collections decision making.

Plants are essential to achieving a botanic garden’s mission whether the mission is to conserve plant diversity and diversity, conserve species and their genes, adapt landscapes to climate change, provide botanical knowledge, or preserve historical legacies. To identify priorities for plant collections management, botanic gardens use integrated collections development.

Defining integrated collections development

The process of collecting and evaluating information about a garden’s holdings, as well as the holdings of others, to make complementary and synergistic collection management decisions including acquisitions, propagations, and distributions, in order to maximize diversity within and across species” (Meyer, 2009). The goal is to “nurture the natural evolution of limited resources [to] achieve the greatest conservation impact.”

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Things to think about

- **Scope**
  - Broad vs. targeted
  - Determining relevant partners and including them early

- **Data management**
  - Gathering and compiling data
  - Updating analyses

- **Information sharing**
  - How to communicate results
Scope Refinement

Conservation Gap Analysis of Native U.S. Oaks (Beckman et al. 2019)

- 91 species; spatial analysis of 28 species (of conservation concern)

Global Conservation Gap Analysis of Magnolia (Linsky et al. 2022)

- 336 species; spatial analysis of 28 (threatened) species
Surveys: Data Acquisition

- Comprehensive, global representation
- Insight at species and accession level
- Sourcing *in situ* data information
Surveys: Data Acquisition

- Comprehensive, global representation
- Insight at species and accession level
- Sourcing in situ data information

- BGCI PlantSearch
- ArbNet members
- American Public Gardens Association members
- AABGACOL Listserv
- Center for Plant Conservation
- Plant Conservation Alliance
- Southeast Asia Botanic Gardens Network
- Chinese botanical gardens
- PlantNetwork members
- Global Trees Campaign partners
# Spatial Analysis

<table>
<thead>
<tr>
<th>C</th>
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<th>F</th>
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<td>C</td>
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<td>-82.067684 Crabtree Meadows; on the</td>
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## Spatial Analysis

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Mapping & Spatial Analysis

Ex situ representation of in situ occurrence

Magnolia fraseri
Mapping & Spatial Analysis

Ex situ representation of in situ occurrence

Magnolia fraseri

a) Geographic coverage = CAE/CAI = 45%

a) Ecological coverage =
#Ecoregions in CAE / #Ecoregions in CAI = 77%

= Proxy for genetic diversity
Species level comparison

![Bar chart showing estimated percentage of geographic and ecological coverage of diversity represented in ex situ collections for different species of plant. The species are: M. acuminata, M. ashei, M. fraseri, M. grandiflora, M. macrophylla, M. pyramidata, M. tripetala, and M. virginiana. The chart indicates different levels of coverage with orange and blue bars.]
Final Analysis & Prioritization

Combining other metrics along with ex situ to prioritize:
- threat assessments (IUCN Red List, NatureServe)
- exceptionalism (germplasm storage options)
- protective legislation
- vulnerability assessments
  - climate change vulnerability
  - pest/disease vulnerability
# Final Analysis & Prioritization

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Things to think about

- **Scope**
  - Broad vs. targeted
  - Determining relevant partners and including them early

- **Data management**
  - Gathering and compiling data
  - Updating analyses

- **Information sharing**
  - How to communicate results
Climate Assessment Tool

https://cat.bgci.org/

Select a garden

Enter a country or garden name...

or enter the latitude and longitude of a location:

Latitude  Longitude
Climate Assessment Tool

https://cat.bgci.org/

Location

Current

Emissions Limited

SSP2

RCP4.5 by 2050

Business as Usual

SSP3

RCP7.0 by 2090

Taxon

Climate Change Scenario

Assessment

Latitude

Longitude
Climate Assessment Tool

Assessment Results
for taxon Magnolia fraseri Walter
at garden The Botanic Garden of Smith College (United States of America)
with climate change scenario Current conditions
### Climate Assessment Tool

**Assessment Results**

**for taxon Magnolia fraseri** Walter

**at garden The Botanic Garden of Smith College (United States of America)**

with climate change scenario

![Current conditions](image)

#### Temperature in Celsius

| Source         | Records | MAT  | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | Updated At | Hottest Month | Coldest Quarter | Annual Precipitation | Driest Quarter |
|----------------|---------|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|      |              |               |                 |                |
| GBIF BSCI      | 158     | 12.2 | 0  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 2  | 2  | 3  | 3  | 3  | 3  | 2  | 2  | 2019-06-13 | 28.3 °C       | 2.9 °C          | 1363.5 mm/year   | 292 mm/qtr   |
| GBIF Current   | 453     | 12.0 | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  | 2  | 3  | 3  | 3  | 2  | 2  | 2020-10-14 | 27.7 °C       | 2.7 °C          | 1402 mm/year    | 300 mm/qtr   |
| Model          | 0       | 12.2 | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 2  | 2  | 3  | 3  | 3  | 3  | 2  | 1  | 1  | 2021-06-20 | 0             | 0               | 0                | 0             |
| PlantSearch    | 60      | 10.5 | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 2  | 3  | 3  | 3  | 2  | 2  | 2  | 1  | 1  | 2023-05-18 | 26.9 °C       | 2.3 °C          | 1040 mm/year    | 195 mm/qtr   |

#### Projected climate details at garden based on selected climate scenario:

- **Mean Annual Temperature (BIO1):** 8.9 °C
- **Maximum temperature of the hottest month (BIOS):** 28.9 °C
- **Minimum temperature of the coldest quarter (BIO11):** -3.4 °C
- **Annual precipitation (BIO12):** 1149 mm/year
- **Precipitation of the driest quarter (BIO17):** 258 mm/qtr

#### Risk Codes

- **0**: Species not known to occur at this temperature
- **1**: At the edge of the known temperature for the species
- **2**: Species known to occur at this temperature
- **3**: Species mostly occurs at this temperature
Climate Assessment Tool

Assessment Results
for taxon Magnolia fraseri Walter
at garden The Botanic Garden of Smith College (United States of America)
with climate change scenario Emissions Limited in 2050 (SSP2)

| Source            | Records | MAT  | 3°  | 4°  | 5°  | 6°  | 7°  | 8°  | 9°  | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | Updated At | Hottest Month | Coldest Quarter | Annual Precipitation | Driest Quarter |
|-------------------|---------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|---------------|----------------|-------------------|---------------|
| GBIF BCGI         | 158     | 12.2 | 1   | 1   | 1   | 1   | 1   | 2   | 2   | 3   | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 2019-06-13 | 28.3 °C       | 2.9 °C          | 1363.5 mm/year    | 292 mm/qtr   |
| GBIF Current      | 453     | 12   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 2   | 3   | 3   | 3   | 2   | 2   | 2   | 1   | 1   | 2020-10-14 | 27.7 °C       | 2.7 °C          | 1402 mm/year     | 300 mm/qtr   |
| Model             | 0       | 12.2 | 0   | 0   | 0   | 1   | 1   | 1   | 2   | 2   | 3   | 3   | 3   | 3   | 2   | 1   | 1   | 1   | 2021-06-20 | 0             | 0               | 0                | 0             |
| PlantSearch       | 60      | 10.5 | 0   | 0   | 1   | 1   | 1   | 2   | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 1   | 1   | 1   | 2023-05-18 | 26.9 °C       | 2.3 °C          | 1040 mm/year     | 195 mm/qtr   |

Projected climate details at garden based on selected climate scenario:

Mean Annual Temperature (BIO1): **11.3 °C**
Maximum temperature of the hottest month (BIO5): **31.6 °C**
Minimum temperature of the coldest quarter (BIO11): **-0.9 °C**
Annual precipitation (BIO12): **1191 mm/year**
Precipitation of the driest quarter (BIO17): **280 mm/qtr**

Risk Codes:
- **0**: Species not known to occur at this temperature
- **1**: At the edge of the known temperature for the species
- **2**: Species known to occur at this temperature
- **3**: Species mostly occurs at this temperature
PlantShare

https://plantshare.bgci.org/

1 Result

Lauraceae

Persea podadenia

- The Huntington Library, Art Museum and Botanical Gardens
- Collection Date: 1992-12-07
- Provenance: Wild (W)
- Acc.: HBG 73461
- Material type: Plant
- Open pollination: Yes
- Location: MEX / San Carlos / Tamaulipas / 3500 m

Add to Requests
Thank you!

Data contributors, field experts, collection managers, developers, testers, conservation enthusiasts!
MANAGING META-COLLECTIONS DATA:
Tools, Tricks and Lessons

APGA 2023 Workshop, Fort Worth Texas
BOTANIC GARDENS – ANCIENT WORLD

Hanging Gardens of Babylon (500BC), a 16th-century hand-coloured engraving by Martin Heemskerck. Seven wonder of world

Shennong Emperor (250AD); Statue in Jiaozuo Mythical emperor/deity who collected medicinal plants from around world
HISTORY OF MODERN BOTANIC GARDENS

Botanical Garden of Padua the oldest academic botanic garden still at its original location

Botanic Gardens Kew: From Physics garden to display of colonial empire
TODAY: AN AESTHETICALLY PLEASING BUT ALSO EDUCATIONAL COLLECTION...
TODAY: AN AESTHETICALLY PLEASING BUT ALSO EDUCATIONAL COLLECTION…
BUT ALSO OF CONSERVATION VALUE
HOW WE ARE DOING?
GLOBAL STRATEGY FOR PLANT CONSERVATION (GSPC)

**Purpose:** to halt current and continuing loss of plant diversity

**Goal:** reach 16 measurable TARGETS by 2020

At least 75% of threatened plant species in ex situ collections, and at least 20% available for recovery/restoration programs by 2020.
Botanic gardens are Preventing Extinction

Botanic garden statistics from GardenSearch
- Seed bank: 278
- Tissue culture facilities: 133
- Ex situ conservation programme: 326
- Involved in re-introduction: 199

Center for Plant Conservation -
National Collection contains 788 native, rare species being conserved in genetically diverse ex situ collections by botanic gardens.
**METACOLLECTIONS:**
Working together to prevent Extinction

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**TOWARD THE METACOLLECTION:**
Coordinating conservation collections to safeguard plant diversity

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**THE LARGEST FORCE FOR PLANT CONSERVATION**

Worldwide, over 3,000 botanic gardens maintain at least one-third of all known plant diversity. The collective conservation power of botanic gardens is essential to stop plant extinction. Networks allow gardens to coordinate efforts to save endangered plants. The global web of botanic gardens is the world’s largest force for plant conservation – as long as it is well coordinated!

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Botanic gardens hold existing plant diversity, such as these palms at Montebello Biological Station, coordinating and synthesizing living collections together for new benefits for conservation.

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A single plant grown at a garden can contribute to conservation, but it takes many plants to capture sufficient genetic diversity and thus safeguard species for the long term. So, gardens might ask, “Which plants should I grow and how many?”

Genetic conservation science applied to real-world scenarios shows how well our garden networks are to safeguarding plant biodiversity. A close look at the genetics of collections of exceptional plant species – and how they are reinitiated among genetically diverse populations across the globe – shows that the conservation status of many species are changing quickly and how they can do better in the future.

Here we present recent discoveries and recommendations for capturing and maintaining diversity in a client collection, and from these provide practical guidelines for garden managers to advance conservation. We introduce and illustrate the METACOLLECTION concept, with examples of different areas. We provide an overview of sampling strategies for capturing diversity, and provide examples of how gardens can leverage methods developed by the zoo community to collectively manage conservation collections.
WHAT IS NEXT?
SHIFT FROM SPECIES FOCUS TO GENETICS

Biodiversity conservation - saving many species

Biodiversity also is about “genetic diversity”

Genetically diverse collections
INCREASING THE GENETIC VALUE

What is a genetically valuable collection

• Captures species diversity
• Regional representation (geographic)
• Maximum diversity over time.
HOW TO MAKE OUR COLLECTIONS GENETICALLY ROBUST

Our collections were not built with conservation in mind.
Most collections not made for Genetics

Limited number of sources

High redundancy

Could limit genetic value

Potential waste of resources

NOT ALWAYS EASY
HOW TO MAKE OUR COLLECTIONS GENETICALLY ROBUST?

• Meta-collection
  • No one institution can do it all.
  • Having "sufficient diversity requires many plants"

• Focused collections
  • Identify gaps
  • Identify strengths

• Record keeping
  • From collection to death
  • Within & between institutions

• Pedigree
  • Track individuals
  • Identify genetically unique individuals
  • Minimize losses.
ZOO’S HAD SAME PROBLEM
AND MADE CHANGES.

Basic data is useful for making decision
- Where plants are
- Where they came from
- Where they are moved

Other packages can be used to managed Demographic and genetic information
- Easy to transfer above data into these packages
HOW ARE WE DOING?

CASE STUDY:
Amorphophallus titanum
Influence of metapopulation dynamics on genetic structure: Case study of the endangered and exceptional species *Amorphophallus titanum*

Olivia Murrell
Botany 2022

Co-authors: Zoe Diaz-Martin, Kayri Havens, Andrea Kramer, Jeremie Fant
WHY THE CORPSE FLOWER?

- In collections for almost 120 yrs.
- A charismatic member of Garden collections
- Important educational tool.
- Mixed life-cycle (seed and clonal)
Surveyed 140 institutions (BGCI/CBG)
Accession records and individual plant records
Source/Collector and Maternal and Paternal lineage
Bloom records and Distribution

We received data from 156 institutions
Records of 1140 plants (Dead/Alive)
OBJECTIVES

1. Identify source of genetic diversity ("founders")

2. Find out where it is (Transfers)

3. See how it has changed (Breeding)
OBJECTIVES

1. Identify source of genetic diversity ("founders")
2. Find out where it is (Transfers)
3. See how it has changed (Breeding)
META-COLLECTION MANAGEMENT

• For Meta-collections aims to collectively keep maximum diversity
  • This can mean different genetics at different institutions
  • Minimize redundancy

• Maximum diversity comes from founders
  • Where original individuals come from
  • And who got what
1878 In August 1878, Odoardo Beccari sent seeds and corms back to Italy but the corms rotted in customs in Marseille. Seeds were shared with several institutions in Europe and 10 years later a flower emerged at Kew.

1914-1930
There were at least 14 expeditions recorded from 1914 through the 1930’s and at least 10 blooms recorded during that period.

1990s
In the 1990’s, Symon (1994), Hetterscheid(1994) and Giardano (1999) dominated the published field work and introduced new genetic material throughout North America and Europe.
NUMBER OF FOUNDERS?

- Material was distributed to anywhere from 1-20 institutions

At least 20 documented expeditions since discovery in 1878.

- So often unknown origins

A number of institutions name 13 commercial sources
WHAT WE LEARNED...

Take Homes

- Many expeditions
- Material shared among a number of institutions
- Most material shared within Continental groups
- Few individuals remain from older collections
  - “limited life span”
OBJECTIVES

1. Identify source of genetic diversity ("founders")
2. Find out where it is (Transfers)
3. See how it has changed (Breeding)
META-COLLECTION MANAGEMENT

• Important part
  “Meta-collections” is tracking your genetics
  • Where did it go
  • This allows us to incorporate genetics into decision making

• We recorded movement using a pedigree
  • Tracking transfers between institutions
  • Was it seed or was it vegetative
SPREAD OF SYMON-ATTENBOROUGH COLLECTION IN 1993

JAHN & KOERNICKE COLLECTION
WHAT WE LEARNED

Over a quarter had no data on what was shared (including WILD)

- Lack of information can make it hard to identify original sources
- Can limit the genetic value of the collection
- Can use molecular study to correct

Tracking Back to founder was not always possible

Of those we did – it was evenly asexual and clonal

<table>
<thead>
<tr>
<th></th>
<th>Seed</th>
<th>Asexual</th>
<th>?</th>
<th>Totals</th>
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<tbody>
<tr>
<td>Transfer</td>
<td>204</td>
<td>234</td>
<td>141</td>
<td>579</td>
</tr>
<tr>
<td>Wild (Founders)</td>
<td>60</td>
<td>9</td>
<td>19</td>
<td>88</td>
</tr>
</tbody>
</table>
OBJECTIVES

1. Identify source of genetic diversity ("founders")
2. Find out where it is (Transfers)
3. See how it has changed (Breeding)
META-COLLECTION MANAGEMENT

- Decisions we make can impact diversity
  - Aside from deciding how diversity is distributed across the meta-collections.

- Crosses have important impact on the diversity of next generation
  - Pollen source
  - Number of “siblings made”

- Amount of asexual propagation will impact representation of individuals
  - Redundancy
GENETIC CHANGES OF COLLECTIONS

Clonal reproduction

- maintains the genetic diversity of wild
- Can over represent some individuals

State of Meta-Collection

- Just under 50% of meta-collection is clonally derived
GENETIC CHANGES OF COLLECTIONS

Sexual reproduction
• Will mix diversity
• Need to know both parental components

State of Meta-collection
• Flowering more common
• 39 recorded crosses (13 EU/25 N.Am/1 Aus)

<table>
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<tr>
<th>Time Period</th>
<th>Flower Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1880-1930</td>
<td>8</td>
</tr>
<tr>
<td>1930-1980</td>
<td>14</td>
</tr>
<tr>
<td>1980-2000</td>
<td>31</td>
</tr>
<tr>
<td>2000-2022</td>
<td>670</td>
</tr>
</tbody>
</table>
FEW CROSSES GO FAR

<table>
<thead>
<tr>
<th>Symon, Hetterscheid</th>
<th>U of Wisconsin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>U of Illinois seed 2001/2011</td>
</tr>
<tr>
<td>U of Missouri 1993/98</td>
<td>1993 seeds 2003 seedlings</td>
</tr>
<tr>
<td><strong>U of Wisconsin</strong></td>
<td>Lacomia NH seed 2001/2006</td>
</tr>
<tr>
<td>St. Paul 2011 seed</td>
<td></td>
</tr>
<tr>
<td>U of Washington</td>
<td></td>
</tr>
<tr>
<td>Smith College, MA 1995/2005</td>
<td></td>
</tr>
<tr>
<td>Berkeley seed 1995/2006</td>
<td></td>
</tr>
</tbody>
</table>
WHAT WE LEARNED
Botanic Gardens are good at maintaining plants.

- Most plants from recent collections
- Census size does not equal the Genetic population sized
  - over ~2800 records
  - only 20 collections
- Individuals not of equal genetic value
  - Just under ~50% of plants in collections are derived from asexual reproduction
New Genetic diversity is not created just moved around

SPREAD OF DIVERSITY?

• Founders not evenly distributed
  • Most modern plants from recent collections
  • Many of original collections are lost OR data incomplete

• Most plants within a continent are from same collection

• Transfer data incomplete
  • Although within institution was great
  • Between was poor
WE ARE NOT MAKING DECISION BASED ON GENETICS

MAINTAINING DIVERSITY?

- Collection data was incomplete
  - Never sure if seed was collected from same one or multiple plants

- Crosses based on opportunity
  - Increases likelihood of inbreeding

- Poor tracking of crosses
  - Of both pollen and seed
  - Most material from few crosses and few institutions
CONCLUSION

Meta-collections approach critical to save species genetic diversity of collection

Better records need to track sources and movement of individuals (Big Data)

Software and models exist but need to be modified

BGCI and SCTI is happy to work with us.
WE NEED OUR OWN PROGRAMS

Data Management is critical
Basic data is useful for making decision
- Where plants are
- Where they came from
- Where they are moved

- Other packages can be used to managed Demographic and genetic information
- Easy to transfer above data into these packages
WHAT IS THE GOAL?

1. Identify Founders to maintain their genetics
2. Track individuals to know who has what?
3. Identify changes so we can make informed decision to maintain diversity and prevent inbreeding
Botanic Gardens and Institutions

Hortus Botanicus Amsterdam
University of Basel Botanical Garden
Universität Bern Botanical Garden
Binghamton University
Ruhr-Universität Bochum
Botanic Gardens of South Australia
Botanic Garden of Smith College
Jardin des Plantes de Caen
Cambridge University Botanic Garden
Chester Zoo
Chicago Botanic Garden
Universiteit Gent Botanic Garden
Duke University
Frederik Meijer Gardens
Jardin Botanique Jean-Marie Pelt
Herrenhausen Gardens
The Huntington Library, Art Museum, and Botanical Gardens
Juniper Level Botanic Garden
Lauritzen Gardens
Jardin Botanique de Liège

Acknowledgements

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(MG-60-19-0064-19)

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Northwestern University
Plant Biology and Conservation Research Award

Colleagues

Olivia Murrell, Chicago Botanic Garden
Zoe Diaz-Martin, Chicago Botanic Garden
Kayri Havens, Chicago Botanic Garden
Nyree Zerega, Chicago Botanic Garden
Mark Hughes, RBG Edinburgh
Andrea Kramer, Chicago Botanic Garden
Abby Meyer, BGCI-US
Phil Douglas, Chicago Botanic Garden
Justin Tuff, University of Illinois, Chicago
Bob Lacy, SCTI
Taylor Callicrate, Chicago Zoological Society
Kathy Traynor-Holzer, SCTI

and 61 others
WHAT IS NEXT?
IMLS National Leadership Research Grant
Botanic garden ‘metacollections’

Central challenge: manage genetic diversity across numerous institutions (like zoos), via 3 tasks

1. **Enable better measures of collections sufficiency**
   
   Using case studies, compare GIS-based metrics of metacollection sufficiency to DNA-based metrics

2. **Large-scale assessment of duplication** (i.e., “backup”)
   
   Assess levels of duplication (i.e., “backup”) among institutions for metacollections (oaks, walnuts, magnolias and more)

3. **Assessment hybridization** in botanic gardens.
   
   Use DNA sequencing in 3 genera to assess hybridization across dozens of institutions (for the first time, we think!)
Are hybrids masquerading in our collections? Use DNA sequencing to detect hybrids for four species groups, in hundreds of plants, across dozens of institutions (Magnolia zenii and stellata; Magnolia fraseri and pyramidata; Juglans hindsii and californica, Quercus boyntonii and other Quercus).

We assume sampled seed is true to the parent species, and grow or share it with other gardens - but are we assuming too much?
BREAK
Metacollection Case Studies: what to Consider when Planning a Metacollection Site

GCCO Lead: The Morton Arboretum
Presentation made by: Amy Byrne (The Morton Arboretum, GCCO Coordinator)
Develop coordinated ex situ collections of high conservation value

Recommendations:

- No one garden or collection can (or should) hold all plants; a coordinated *metacollection* model is needed

- To ensure high conservation value, living collections should capture **maximum wild genetic diversity**
Developing climate resilient collections
Metacollection Partnership Program

- Creation of genetically diverse and climate resilient conservation groves
- Metacollection partnership program
  - Beech Creek, NC
  - Francis Marion, SC
  - Ocean Knoll Elementary School
  - Oak Glen Preserve
  - ...and hopefully more!
Beech Creek Seed Orchard, Oak Conservation Grove

- Q. boyntonii and Q. georgiana planted
- The groves were established to maximize genetic diversity capture
- Trees being managed by Seed Orchard Managers, Technicians and the Arboretum Partner
- >100 oaks planted
- Growth data being collected
Establishing a Metacollection site

Considerations:
- Complementarity with existing sites
- Management (irrigation, security, accessibility)
- Number of plants to include: capturing sufficient genetic diversity
- Climate resiliency: set up for long-term success and sustainability
- Plan for the desired outcomes of the site
- Who can help to achieve desired outcomes?

Resources to help:
- Metacollection guidelines (part of the resources list when you scan the QR code)
- Metacollection guidance brief (in progress, will be shared later this year)
Goals of your Metacollection

What do you wish to achieve with your metacollection?

Take five minutes to discuss as a group; write down 3-5 goals!
Challenges to Developing a metacollection

What are some challenges you face in developing a metacollection?

- Space?
- Plant material?
- Expertise?

Take five minutes to discuss some challenges and what may be needed to overcome them!
WRAP-UP